Engineering Record

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The War and the Publisher

ATTENTION was called in these columns some months ago to the change in producing the red cover of the Engineering Record caused by the shortage of dyestuffs. More recently the war has had an even wider effect and few of the materials entering into the makeup of a magazine can now be secured except at prices ranging from 50 to 150 per cent above what they were a year ago. The shortage of wood pulp and of chemicals used in paper making, due to the shutting off of supplies from abroad, has brought about an acute situation in the paper field. So serious is it that one well-known trade paper does not know at this writing whence it will secure stock for its next week's issue. Inks have gone up over 200 per cent, and an engraving scale representing increases ranging from 50 to 150 per cent becomes effective April 3. A disturbing feature of the present situation is that no relief, other than the sudden cessation of the war, is in sight.

Centennial of the Geodetic Survey

WITH commendable pride the U. S. Coast and Geodetic Survey is planning to celebrate the centennial of its establishment April 5 and 6. An elaborate program of addresses, which will bring forth the achievements of the survey and the relations it holds to other departments of the government, has been prepared. The President of the United States will grace the banquet which, on the evening of April 6, will close the proceedings. It is gratifying to note that an engineering branch of the government so clearly visualizes its work, its responsibilities and its accomplishments as to take advantage of the opportunity to stand before the public and glory in the completion of a century of work well done. The survey is to be congratulated on rounding the century mark, and even more so on the esprit de corps and professional pride which prompted the centennial celebration.

To Discourage Efficiency

LAST year, through the sneaking ruse of a "rider" on an appropriation bill, the Congress of the United States prohibited the making of time studies and the payment of bonus for increased efficiency in establishments of the War Department. This year even broader legislation is planned by those opposed to these methods of obtaining increased efficiency. Congressman Travenner on Jan. 11 introduced a bill which would prohibit time-study work in any government establishment and the payment of premiums, bonus or cash rewards as additions to wages, except for suggestions resulting in improvement or economy in operation. A similar bill, introduced by Congressman Van Dyke on the same date, would prohibit time studies throughout the postal service. The introduction of these measures, however unfair and however detrimental to the nation's work, should cause little surprise. What is intolerable, however, is that so far the committee on labor of the House has granted no hearings on the measures. There is ground for suspecting that the same tactics—the sneak's method—which resulted in putting the rider on last year's army bill is in contemplation for the Travenner and Van Dyke measures. It needs only the strong light of publicity to show the insidious and baleful influences of these proposed laws. The country at large, therefore—citizens interested in improvement of government efficiency, manufacturers, engineers—should voice their protests to their senators and congressmen at the failure to hold hearings. If the citizens declare themselves the hearings will be granted, and if the hearings are granted there is little likelihood that this extremely unfortunate legislation will prevail.

Junk

THE Board of Water Commissioners of an Eastern city has just issued an annual report which is an example of the extreme limits to which city officials will go in foisting upon a long-suffering public a mass of utterly useless information concerning departmental activities. The booklet contains 65 pages. In order to arrest the attention of the reader at the outset it opens with a list of names of deceased and present members of the commission, arranged chronologically and covering the period from 1867 to 1916. There follows a two-page statement regarding several details of engineering work and then comes the big feature—the secretary's statement of receipts and disbursements. No less than twenty-three pages are devoted to tabulated trivialities of expenditures such as: "Berry's Cut Rate Drug Store, 20 cents; Elmer E. Ayers, 15 cents," etc. It all makes such interesting reading that the man who has progressed through a score of pages like this will feel a compelling desire to proceed further. His determination will not be without its reward—several pages on hydrant and valve locations. Here is a sample: "Jefferson Avenue, corner of Mozart Street, two 6-in. gates; Mozart Street, south of Jefferson Avenue, one 6-in. gate, etc." At this stage the reader becomes so thoroughly aroused that he simply cannot put the booklet down until he has digested thoroughly the next chapter, giving the names of streets on which pipe was laid during 1915. On Baldwin Street, he learns, 50 ft. of 12-in. pipe were laid. This information whets his appetite for more and as he proceeds he finds out that on Alfred Street pipe laying activities were in progress for a length of 165 ft. The climax of the report is reached in the concluding paragraph, "Extracts from Rules of Water Board." With a sigh of regret that the end has been reached so soon the reader lays the volume aside. The one ray of hope for him, however, is that another report will be issued next year.

What Is Wrong?

"THE city engineer's office seems to be a school for the preparing of young engineers to take other positions. Are the salaries too small or is the training too good? No young man can be blamed for endeavoring to advance his own interests, but the numerous graduations are causing a lot of comment." Regarding the frequent graduations referred to in these sentences from the *Daily Vindicator*, Youngstown, Ohio, the Engineering Record has no information. The salaries may be too small, the opportunities too limited, the working conditions unsatisfactory, or the openings in the Youngstown district at present many and attractive. The condition described, however, is not at all uncommon in the offices of city engineers in normal times. Probably the principal reason is that young engineers can see but comparatively little opportunity ahead in municipal work—at least when opportunity is gaged by the present common standard of remuneration. Oftentimes the salaries in the lower positions are entirely satisfactory. The young man who has a college education, however, is accustomed to look to the future, and that often has a discouraging aspect in the city engineer's office. Without a doubt, when the public comes to a keener appreciation of the engineer's work and his responsibilities, the remuneration paid to the city engineering force will go up. Probably then there will be less difficulty in holding bright young men.

Service of Engineering Societies

MANY questions affecting the efficiency of engineering societies will be brought up by the conference on society co-operation which will be held in Chicago April 13 and 14. Underlying them all, however, is the fundamental one, Why does an engineering society exist? Asked in all its baldness, the inquiry seems childish, yet the plans predicated on the answer spell society efficiency, mediocrity or utter failure. The all inclusive answer is that a society exists to render service to its members. Then comes the question as to what that service shall be.

Shall it be prestige, as is largely the case in the American Society of Civil Engineers; shall it be technical information, as in the American Society for Testing Materials and the American Railway Engineering Association; shall it be personal service as in local organizations? Plainly there are different types of acceptable service. But once the type has been selected, the officers and governing boards must ever keep it before themselves and the membership. This has been done in the testing materials and railway engineering associations, as regards their ideal of developing and accumulating technical information. It has been done by the local societies in giving employment aid, in offering opportunity for social intercourse and a forum for the discussion of local engineering problems. Some of the larger societies are less definite in their ideals of service; and in that indefiniteness can be found the cause of much of the dissatisfaction which has been expressed for example, among the members of the American Society of Civil Engineers. Some years back the members apparently considered that the prestige of belonging to the society was an adequate return for their dues. Such is no longer the case. More tangible returns are expected. The requirements are seldom formulated; they are given general expression by saying that the society should "do something" for its members. The receipt of the Proceedings and the privilege of wearing the pin do not satisfy the "something" that is demanded. A satisfied membership, an enthusiastic membership is one that is being adequately served, and service is possible only when officers and governing bodies continually ask themselves, "What *should* the society do for its members? What is it *actually* doing?"

High Cost of Motor Fuels

While we hear a good deal about the troubles of the motorist in connection with the high price of gasoline, the man who uses motor trucks or gas engines for any purpose in his business is entitled to a greater share of our sympathies. The motorist can lay up his car; the man who is using gas engines for industrial purposes cannot very well shut down. There is no immediate prospect of materially lower prices for motor fuel, notwithstanding efforts of congressmen to prosecute producers and the resolutions instructing vaious bureaus to investigate what one congressman calls "the evident oppression of the public" by the producers of gasoline.

According to the government's figures we were approaching a period of scarcity and high prices when the war began. In 1900 the United States produced about 7,000,000 barrels of gasoline; in 1909, 13,000,000 barrels; in 1914, 35,000,000 barrels, and in 1915, 42,000,000 barrels. The increase in production has, of course been large, but nowhere near as large as the increase in motor vehicles—from a few thousands in 1900 to 2,500,000 in 1915. In addition to the motor vehicles, we have, of course, to consider the great increase in the employment of gas engines for all sorts of industrial service, for farm engines and motor boats.

It appears that a source of relief more promising than congressional resolutions would be a carburetor which would handle kerosene or other distillates. There are several such carburetors on the market already, and they are at least sufficiently successful to warrant their investigation by users of internal combustion motors. This is the only immediate measure of relief from high prices of gasoline and should be availed of while we are waiting for the war to end, for improved processes to increase the output of gasoline, and for the government to exhaust its probably futile efforts to reduce prices through investigation and prosecutions under the anti-trust law.

"Wood Where Wood Is Best"

Speaking before the National Wholesale Lumber Dealers' Association in Philadelphia on March 15, R. S. Kellogg, secretary of the National Lumber Manufacturers' Association, stated that the necessary keynotes of all lumber advertising today are the advocacy of the use of wood only where wood is best, and of the kind of wood that is best for a specific purpose. This, it seems to the Engineering Record, is significant of a new attitude in the lumber industry, and one that ought to be assumed wherever engineering materials and equipment are in question.

We have been accustomed for years to expect that the manufacturer of machinery would not sell his equipment unless it were adapted for the use intended. It is inconceivable, for example, that the maker of a grinding machine or of an expensive turret lathe would sell his product for a use that it could not well fulfill. Nevertheless, sellers of engineering materials of many classes have not set for themselves the same intelligent standard. In paving materials the salesmanship has been particularly flagrant. The salesman has been intent only on exchanging his product for the community's hard cash, regardless of the adaptability of the material to the traffic and conditions on the given street or road. He depended upon the power of his corporation to "get" the engineer in case the product failed and the engineer refused to buy again, upon a change of administration, or upon a lack of records to prevent the real facts regarding the service of his product from becoming known.

In a general sense, this indifference as to the use of the product has been true, also, in the lumber business. The lumber dealer cared not that his material went into the worst sort of fire traps, so long as the flow of money into his pockets constantly increased. Evidently the awakening is here. All true friends of conservation and a sensible economic standard in this country will trust that Mr. Kellogg may go forward and may work out designs in timber construction which will be as highly fire-resistive as possible. The lumber men well know that some types of frame construction resist fire very well, while others furnish just so many flues for encouraging and spreading the flames.

"Wood where wood is best" is a worthy slogan.

Railroad Regulation Case Forcefully Put

Though reiterating views repeatedly expressed in this journal, the following quotation taken from an article by Prof. J. Laurence Laughlin, of the University of Chicago, in the New York *Press* of March 19, deserves a careful reading. Professor Laughlin puts the fundamental difficulty of the railroads—control of revenue by the government, while organized labor, uncontrolled by government, largely determines expenditures—in a clear and forceful way. The conclusion is inevitable. If the government limits earnings, it must limit the expenses which those earnings go to pay.

Professor Laughlin sums up the case in these words:

"In any other industry [than transportation] if the laborers enforce a raise of wages, the employers can raise the price of their product to the consumer. In the case of railways this control over fixing price is denied them.

"What is the upshot of the whole matter? The railways are between the devil and the deep sea. On the one hand, the commission refuses an increase of rates, while on the other the unions demand higher wages, with the threat of stopping the whole trade of the country until their terms are accepted. Where does the public come in? If railways are quasi-public utilities and therefore subject to regulation, then regulation clearly should include the protection of the public.

"If a set of conditions has arisen which obliges the government to regulate rates, then it is equally obliged, on the basis of economic analysis, to regulate wages accordingly. Having taken one step, it must take the other. It is the public which sooner or later must pay for the increased expenses of transportation."

In the difficulty now brewing the railroad employees admit that more revenue may be needed to give them the increase they demand, but their attitude is that they should have their higher wages at once, regardless of the time it will take to get the Interstate Commerce Commission to authorize an increase of rates, and regardless also of the fact that the commission for one reason or another may refuse such an increase. It is true that the commission is not now authorized to investigate the adequacy of wages and to recommend or enforce increases. The men, therefore, cannot lay their case before that body. They could, however, and should accept the conclusion stated by Professor Laughlin and urge Congress to give the commission such authority.

The Engineering Record is not unmindful of the burden such new duties would impose on an already overburdened body. The conclusion, however, is inevitable. A way to handle those duties will eventually have to be found.

Railway Engineering Convention

IN RESPECT to the findings put forth for adoption, and actually adopted, the convention of the American Railway Engineering Association last week was something of a disappointment. "Progress only" was the report on a larger number of topics than usual. This may be due in part to the removal of the incentive to get matter into the *Manual*, on account of the publication of the new edition; and in part to the fact that many of the more common problems have been cleared up. The investigations each year are more and more in the nature of research. One feature of the convention was noticeable—an inclination to lead rather than follow legislation. The general spirit of the convention was an encouraging contrast to that exhibited two years ago, in the quibble over the inscriptions on crossing signs. Then there seemed to be widespread fear lest the action of the association might suggest to legislatures something more drastic than had occurred to them before. The members, evidently, must have perceived that radical legislation is not halted by silence, and it is well that they are now showing an inclination to be the driving force rather than the brake.

A Meeting Well Conducted

COMMENT on the convention would be incomplete without commendation of the masterly way in which President Trimble presided. His eye was ever on the program, his mind was ever on the motion before the house, and digressions were not permitted. At times, perhaps, his rulings were a little too severe, and possibly some of the testimony he deemed irrelevant was not so in fact. He put the convention through on time, however, in spite of the fact that on one or two occasions it appeared that the length of the debate would upset the schedule entirely; and the chief engineers and others whom he called to order, being, like himself, men of affairs who have to get things done without too much ceremony, probably forgot their own discomfiture as soon as they realized the necessities of the situation.

Taking the Lead in Clearances

THE Engineering Record deems it most fortunate that the association did not adopt 14 ft. for side clearances, or send the matter back to the committee and lose a year, or dodge the issue entirely. As was ably set forth by several of the speakers, no body of men in the world is better qualified than the American Railway Engineering Association to determine safe clearances, and if they take no action in the matter, or action that creates the suspicion, just or unjust, that the cost of construction is being given undue weight, they cannot altogether blame the legislative bodies for going wrong in their attemps to insure greater safety. On the other hand, since the association has passed definitely on the matter, the Engineering Record believes, as stated editorially in the issue of March 18, that legislatures can afford to leave the subject alone, or shape their measures to the findings of the association. It is to be regretted that the question of whether the association preferred 15 ft. or something greater was not given a more thorough test. The Engineering Record does not attempt to say whether the 15 ft. adopted or the 16 ft. recommended by the committee is preferable. The closeness of the vote on the 15-ft. question, however, coupled with the fact that the debate on the 14-ft. motion was practically confined to a choice between 14 and 16 ft., raises the suspicion that if opportunity had been given to debate the 15-ft. motion it might have been voted down in favor of something wider.

League for the Defense of Concrete Patent Suits

THE FORMATION of the National Septic Process Protective League (noted in the news columns of the last issue), which will take up and continue the work of an earlier organization, suggests that a similar co-operative movement is needed in order to ascertain the status of the many concrete patents which are now troubling engineers. It is impossible without much thought and study to outline any of the details of such an association. It might be found, after investigation, that it would not be advisable to shoulder the defense of patent suits filed against its members, but merely to furnish the needed resources for a most thorough investigation of such patents as were brought into litigation, the results of these investigations being made available to the members.

There is a strong feeling that comparatively few of the defenses in patent suits affecting concrete work have been well handled. The reason is evident. Much of the material is buried in technical journals in both English and foreign languages and is not readily available. Moreover, it can be brought to light only by painstaking investigation. Without a doubt, too, a tremendous amount of material bearing upon these patents exists here and there in the offices of consulting engineers and of industrial and railroad companies from one end of the country to the other. It has not been collated, however, and consequently the full powers of the defense are not adequately marshalled.

Such a league as is here proposed would bring all of these forces together, and by slight individual contributions would make an aggregate competent to handle defenses in a vigorous and satisfactory manner.

There has been much complaint that consent decrees have been secured by patentees from weak opponents, men who welcomed the opportunity to settle and get off more cheaply than if they undertook a defense. Naturally, a small contractor, with little knowledge of engineering matters, of the prior art or of the technical literature containing records of it, looks with terror upon a suit that may drag out for years and involve not only high legal fees but considerable damages as well. He welcomes an opportunity to compromise and to give a consent decree, the true merits of the case having no interest for him.

Honest patentees, would welcome defense by such an organization. If their patents were sustained in face of such a defense the validity would not be questioned by the courts of appeal other than that in which the particular case was tried.

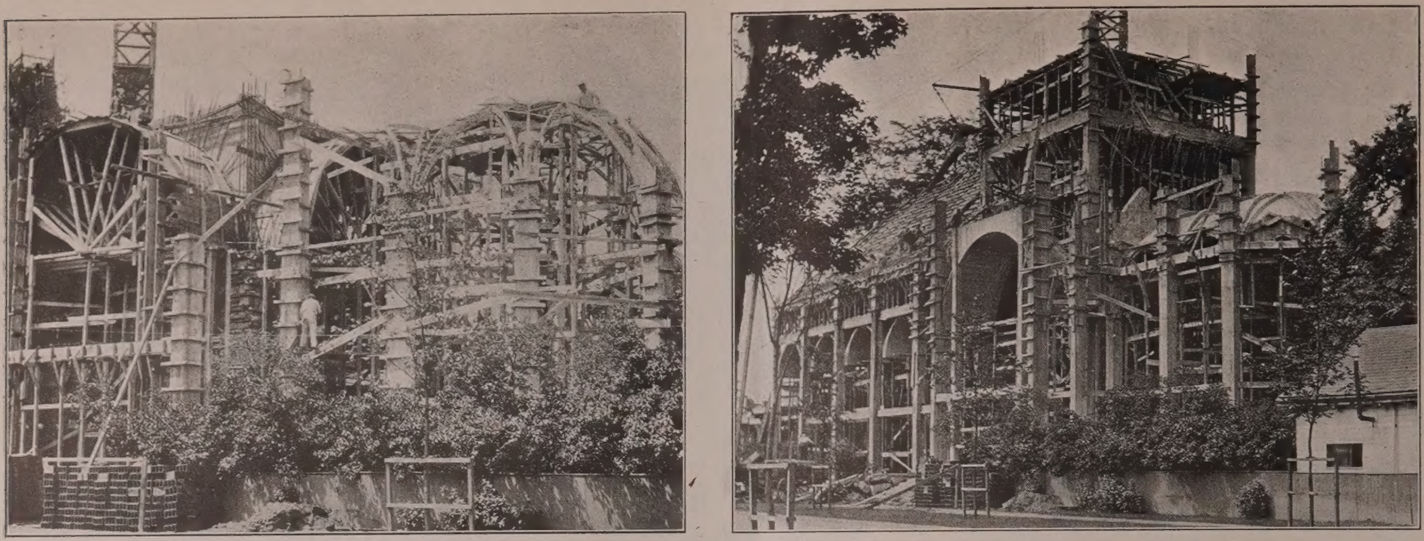
The Engineering Record would like to hear from engineers and contractors as to the desirability for forming such an association. The work awaiting it is large and important—so large and important that it is not likely to be well done if individuals and municipalities continue to act by themselves.

Complex Concrete Building Work

REINFORCED concrete is continually demonstrating its adaptability to almost any form of structural framework, no matter how complicated. Perhaps one of the most unusual and complex applications of this type of construction in building work is in the new Germanic Museum at Harvard University. Combining several styles of architecture, the structure presented many difficult problems in design, and construction. Two articles in this issue, pages 440 and 443, make it evident that the original ideas of the eminent German architects have been successfully translated into solid concrete by the associate architects and engineers in Boston, who applied American methods of designing, placing and finishing the reinforced-concrete frame.

The strong contrast which exists between German and American practice is suggested by Mr. Perry's article on the design. As stated by Mr. Perry, the analysis was based upon simple and reasonable assumptions, because the many statically indeterminate problems made an exact mathematical solution practically impossible. This is in accord with the prevailing American practice. It is quite probable that if the structure had been designed by a German engineer, an elaborate and complete mathematical engineering thesis would have resulted. A glance at the German technical periodicals will show how exhaustively their structures are analysed—the German engineer seems to revel in statically indeterminate problems and the theory of least work.

While in the simpler problems their results are probably nearer the true stresses than those obtained by our methods, in many cases the mathematical analysis itself is based upon fundamental assumptions which are not exactly realized. The American engineer believes that the practical inexactness in the placing of reinforcement, the variability of the concrete in the actual structure, the inaccuracy in form work, and the inevitable uncertainties at the foundations or at the points of combination with other parts make an exact mathematical study more or less a waste of time. The correct position undoubtedly is that the mathematical analysis should be carried to the degree of refinement justified by the nature and probable exactness of the assumptions.



COMPLICATED FORMWORK FOR GOTHIC HALL AND CHAPEL SHOWN IN TWO PROGRESS VIEWS, JUNE 10 AND JULY 26, 1915

Reinforced-Concrete Frame of New Germanic Museum at Harvard Is Unusually Complex

Domes, Vaulted and Arched Ceilings, Octagonal Tower and Roof Used to Obtain Desired Architectural Effects—Difficult Form Work

UNUSUALLY COMPLICATED form work, combined with great variety in the details of design, mark the construction of the new Germanic Museum at Harvard University, Cambridge, Mass., one of the most notable of the recent applications of reinforced concrete to architectural purposes. Especially difficult problems confronted both the architects and the designing engineers because several different forms of construction had to be harmonized and combined in one whole without producing too great complications in the actual details of erection and design. Domes, arches, steeply inclined rafters, special intersecting beams supporting the tower, complicated conical slab connections, and octagonal upper tower and roof all enter into the structural framework.

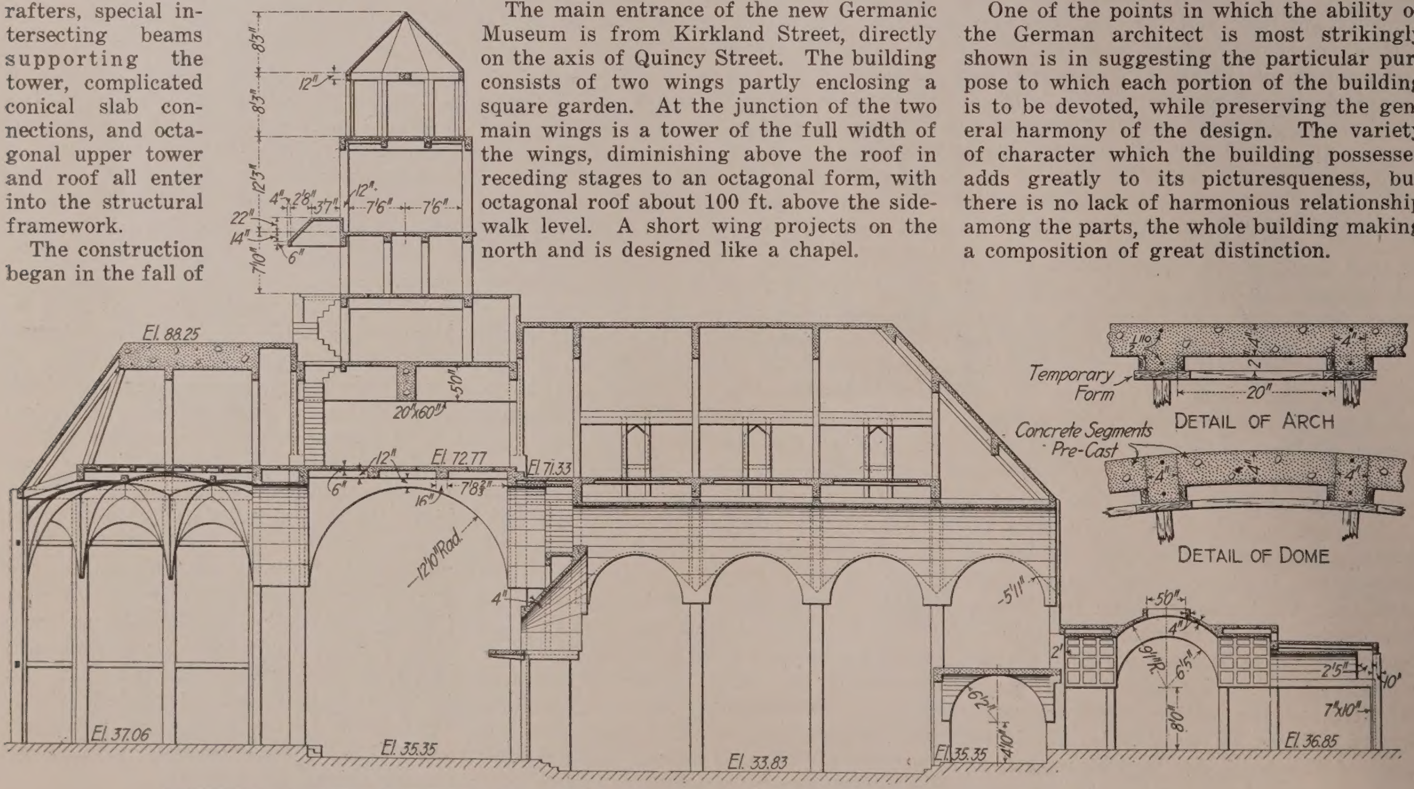
The construction began in the fall of 1914, and the first floor slabs were completed by Dec. 1 of that year. Work recommenced in April, 1915, and the structural frame was practically completed by Sept. 1, 1915. Among the unusual features in the construction work are the use of precast segments of the dome over the front entrance as forms for the concrete ribs, and the screeds on the steeply inclined roof later used as nailing strips for the timber sheathing to which the roof tile is fastened. Special attention is given to the interior finish of the concrete surfaces.

GENERAL ARCHITECTURAL PLAN

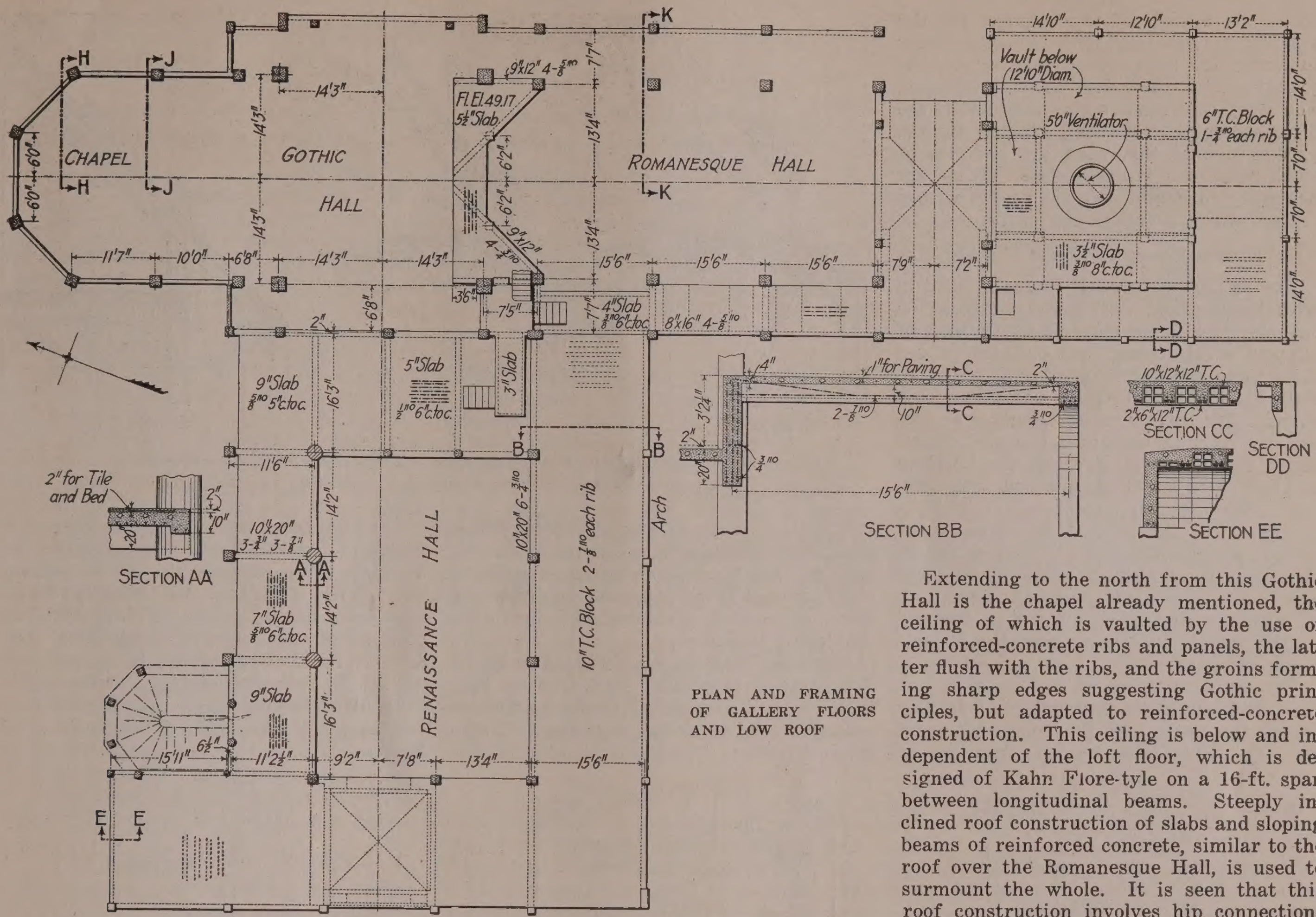
The main entrance of the new Germanic Museum is from Kirkland Street, directly on the axis of Quincy Street. The building consists of two wings partly enclosing a square garden. At the junction of the two main wings is a tower of the full width of the wings, diminishing above the roof in receding stages to an octagonal form, with octagonal roof about 100 ft. above the sidewalk level. A short wing projects on the north and is designed like a chapel.

The design of the whole building is distinctly modern and characteristically German, suggesting in its main characteristics the early German Renaissance. Its different parts are, however, so treated as to suggest, as in the case of the Romanesque wing, the period to which that portion of the building is to be devoted. Thus the chapel beyond the tower, while not Gothic in style, suggests a Gothic chapel in its main outlines and even in the treatment of its vaulting within, while the western wing, which opens from the tower and will contain the objects of the Renaissance period, is decisively Renaissance.

One of the points in which the ability of the German architect is most strikingly shown is in suggesting the particular purpose to which each portion of the building is to be devoted, while preserving the general harmony of the design. The variety of character which the building possesses adds greatly to its picturesqueness, but there is no lack of harmonious relationship among the parts, the whole building making a composition of great distinction.



LONGITUDINAL SECTION LOOKING EAST SHOWS VARIETY IN STRUCTURAL FRAMEWORK AND VARIOUS FLOOR ELEVATIONS



PLAN AND FRAMING OF GALLERY FLOORS AND LOW ROOF

The entrance vestibule, one story high, located in front of the main southern wing to which it leads, is surmounted by a dome with 5-ft. copper ventilator. The accompanying drawing indicates the structural features of this vestibule and dome. On one side is the director's room and on the other a class room and library stack, while on the left a doorway leads into the garden. Directly opposite the entrance is a large doorway leading to the main wing which is to contain objects of the Romanesque period.

The dome was constructed by using the precast unit method for the panels between the reinforced-concrete ribs. These sections, 4 in. thick, were made in multiple units on the ground, with projecting rods to take shear. They were then placed above the rib forms in the proper position and the ribs were cast symmetrically up to the crown, being bonded by the rods.

ROMANESQUE HALL

While not Romanesque in style, the hall just in the rear of the entrance vestibule is designed to suggest the Romanesque and the character of the objects which it is to contain. The main arched ceiling is about 25 ft. in span and is intersected by four arched openings, as seen in the elevations. Instead of barrel arch action, the ceiling is realy a curved slab supported by arched ribs, the latter being outlined by set joints.

FRONT ENTRANCE DURING CONSTRUCTION

The first floor is mainly of the flat slab and girder type of reinforced concrete. The elevation of the floors in the different portions of the building varies, thus separating the different halls and allowing an effective use of classic entrances. The structural design is so planned that the great casts to be installed will form a part of the composition of the interior. A duplicate of the Golden Gate of the Cathedral of Freiburg in Saxony is to be placed at the entrance between the Romanesque Hall and the Gothic Hall under the tower, while the screen from the Cathedral of Naumburg will separate the main Gothic Hall from the chapel beyond, in which objects of ecclesiastical art will be placed.

GOTHIC HALL AND CHAPEL

The Gothic Hall, formed by the intersection of the two main wings, is constructed with an arched entrance on the east. As seen by the elevations, a panelled ceiling above this central hall is formed by the beams of the loft floor at El. 72.77. This is a 6-in. slab floor of reinforced concrete carried by two intermediate beams in each direction to the 12-in. arched walls on all four sides. A stairway from the gallery floor on the south side of this hall leads above the conical slab to the loft floor above. Cantilever beams of reinforced concrete support the gallery floor.

Extending to the north from this Gothic Hall is the chapel already mentioned, the ceiling of which is vaulted by the use of reinforced-concrete ribs and panels, the latter flush with the ribs, and the groins forming sharp edges suggesting Gothic principles, but adapted to reinforced-concrete construction. This ceiling is below and independent of the loft floor, which is designed of Kahn Flore-tyle on a 16-ft. span between longitudinal beams. Steeply inclined roof construction of slabs and sloping beams of reinforced concrete, similar to the roof over the Romanesque Hall, is used to surmount the whole. It is seen that this roof construction involves hip connections which had to be provided for properly in the form work.

RENAISSANCE HALL

The main west wing is to contain objects of the Renaissance style, and is to be roofed with a flat wooden ceiling below the steeply inclined reinforced-concrete roof. On the north side the gallery is carried behind three large monolithic shafts or columns of dark red Vermont marble. These columns were so difficult to obtain that it was necessary to proceed with the construction without them by temporarily shoring up the gallery floor and roof beams by 6 x 6-in. timber columns.

As the top of these marble columns is about 4 in. below the bottom of the roof beams, small pipes were cast in the beams

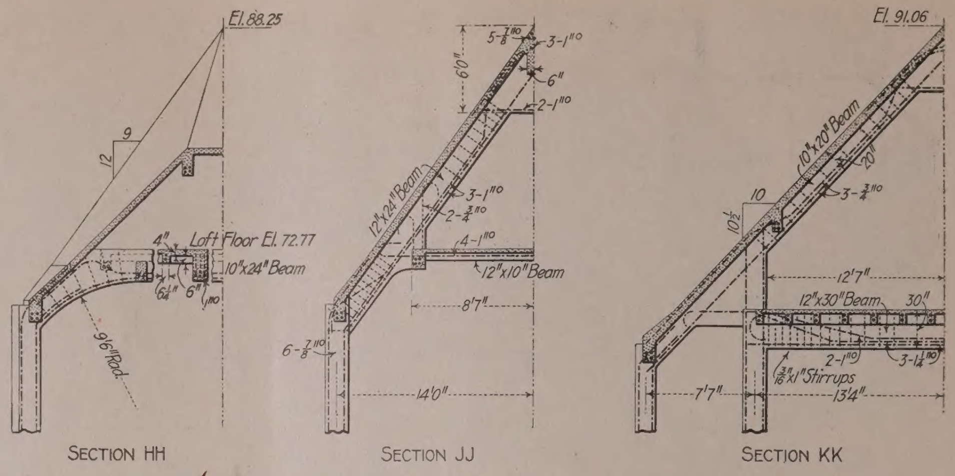
VIEW FROM INTERIOR OF ENTRANCE VESTIBULE SHOWS DOME AND VAULTED ENTRANCE

above the centers of the columns for the purpose of grouting with cement mortar to bring the beams to a bearing on the columns after the latter are set in place. The steep roof construction and details are discussed in the following article. On the garden side of this wing are a series of small rooms for minor objects. These are one story in height and are roofed with a terrace which overlooks the garden.

EXTERIOR AND INTERIOR FINISH

The reinforced-concrete frame is filled in with hard-burned wall blocks plastered on the outside with cement. The main lines of support of the frame are outlined by cut stone piers and lintels forming an enframement for the stucco panels which they surround. The cornice, window enframements and the various entrances are also of cut stone, and the main parts of the building and entrances are richly adorned with carving. Over the main doorway is to be a group of St. George and the Dragon. A group of The Centaur, by Roger Noble Burnham, the American sculptor, who has also executed some other minor figures, is to surmount the stone dormer at the end of the Renaissance wing over the Frisbie Place entrance.

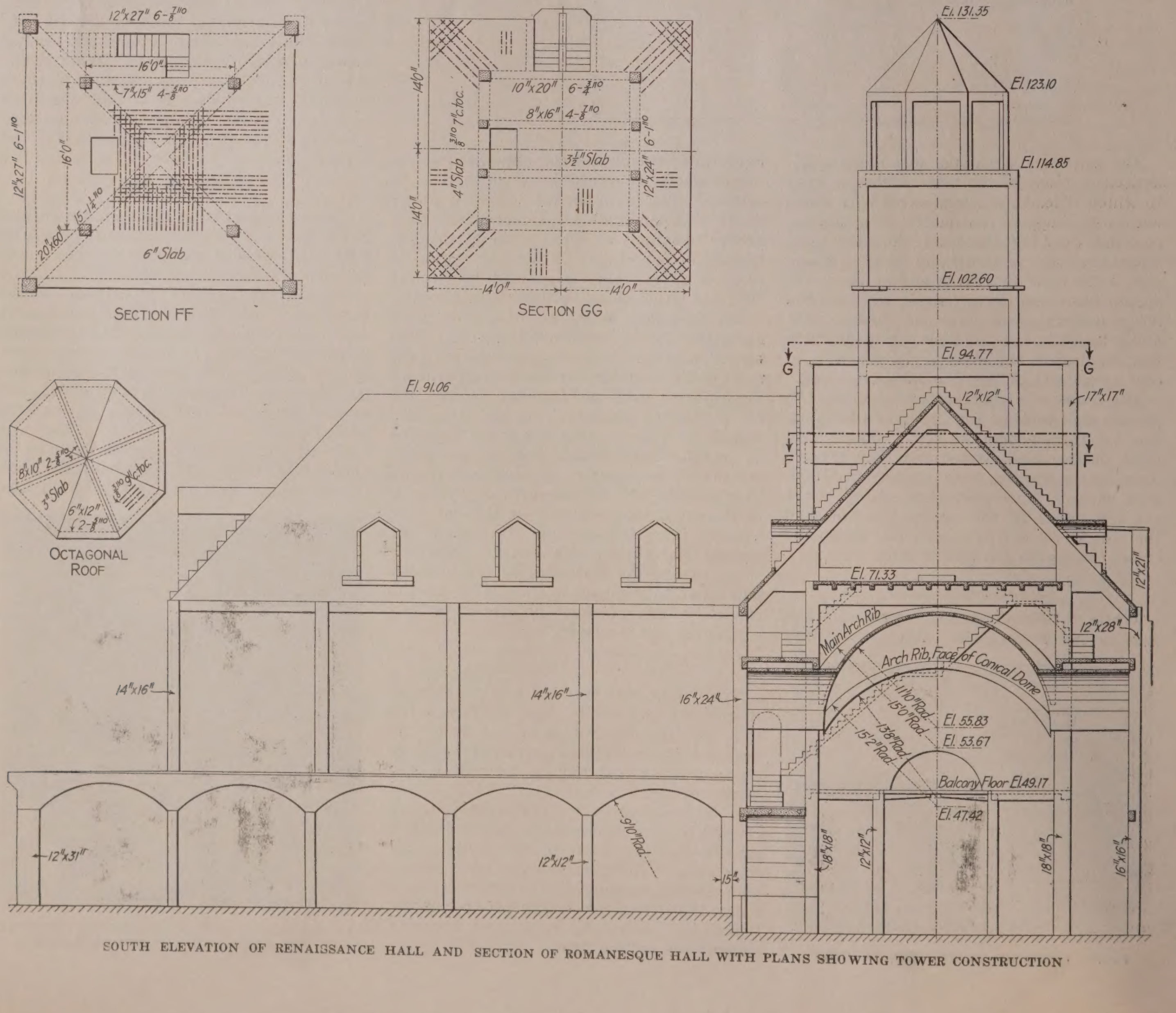
The interior finish of the concrete surfaces will expose the aggregates and frankly reveal the nature of the construction, at the same time removing the form marks and giving a pleasing appearance. While distinctly German in style, in scale the building has been made to relate itself to the immediately surrounding buldings and designed to form a notable addition to the University buildings.



HALF SECTIONS SHOW TYPICAL ROOF RAFTERS AND LOFT FLOORBEAMS

The location of these sections is indicated on the plan view on page 441.

The new building was designed in all its architectural aspects by Prof. German Bestelmeyer, a distinguished German architect recently called to Berlin from the Polytechnic in Dresden. The associate architects in active charge of the work are Warren & Smith of Boston, Mass., who prepared the drawings here reproduced. The working out of the details of the reinforced-concrete work has been done by H. B. Andrews of the Simpson Brothers Corporation, contractors for the framework, in co-operation with J. R. Worcester & Co., and the architects, all of Boston, Mass. The general contractor is W. A. & H. A. Rott, Inc., of Boston.



SOUTH ELEVATION OF RENAISSANCE HALL AND SECTION OF ROMANESQUE HALL WITH PLANS SHOWING TOWER CONSTRUCTION

Design of New Germanic Museum Required Solution of Many Special Problems

Framework of Reinforced Concrete Considered to Be Independent of Enclosing Walls and Designed to Carry Live Loads and Wind Pressure

By CHAUNCEY R. PERRY
Designing Engineer, J. R. Worcester & Company, Boston

MANY SPECIAL problems were encountered in the design of the reinforced-concrete frame of the new Germanic Museum, including analysis of domes, vaulted arch ceilings and multiple beam supports for floor or tower columns. It was realized that a complicated structure of this kind is statically indeterminate and that an exact mathematical analysis is practically impossible. Therefore simple and reasonable assumptions had to be made which would be on the safe side and yet give an economical design. As the framework was constructed independently of the enveloping hollow-tile walls, it was assumed, in nearly all cases, that the structural frame carried only its own weight and all live loads, the walls being considered neither to bring loads upon nor to support the framework, except in the tower.

This article supplements the preceding general descriptive article and will consider the loadings, the allowable unit stresses for the different proportions of mix used in the different parts of the structure, and the assumptions upon which the analysis of the unusual features of the design was based.

LOADS AND ALLOWABLE STRESSES

The assumed dead loads for the design were as follows, in pounds per square foot: Paving for first floor, 45; granolithic finish, 15; boarding, tile, etc., for sloping roofs, 18; roofing for flat roof, 8, and superimposed treads and risers for stairs, 45. The live loads prescribed for most of the first floor rooms and the gallery was 125 lb. per square foot, while 100 lb. was used for the loft floors and main stairs. For the sloping roofs the snow and wind was taken at 32 lb. per square foot, and at 52 lb. on flat roofs. Horizontal wind pressure was considered at 20 lb. per square foot.

The allowable unit stresses adopted were as follows: Stress in steel reinforcement, 16,000 lb. per square inch; stresses in concrete, according to the accompanying table for the different mixtures used.

ALLOWABLE UNIT STRESSES IN CONCRETE—POUNDS PER SQUARE INCH

Kind of Stress	1:2½:5	1:2:4	1:1:2
Axial compression	360	450	675
Compression on extreme fiber	...	650	975
Shear, no web reinforcement	...	40	60
Shear, bent up rods only	...	60	90
Shear, bent up rods and stirrups	...	120	180

Wherever stresses included effect of wind, the above amounts were increased by 25 per cent. The allowable unit pressure on the soil of the foundations was 4 tons per square foot.

BENDING AND SHEAR COEFFICIENTS

The formulas used for bending moment in slabs, beams and girders were: For simple spans, WL/8; for semi-continuous spans, WL/10, and for fully continuous spans, WL/12. The shear for slabs, beams and girders, where semi-continuous, is 0.6 W at the fixed end and 0.4 W at the free end. In regard to this last specification, it will be noted that when a semi-continuous beam carries a semi-continuous slab the maximum shear in the beam is 44 per cent greater than if both slab and beam were either fully continuous or simple spans.

The mix adopted for the main part of structure was 1:2:4, the mass concrete for foundations being 1:2½:5, while for many of the columns a 1:1:2 mix was used. With usual values for cost of concrete ingredients and forms, the rich mix with correspondingly smaller size of column is more economical than the larger column using a 1:2:4 mix. The steel reinforcement consisted mainly of Havemeyer bars, but Kahn bars were used in the rib system of loft floors.

The foundations presented no special problems, as the bearing soil was a firm sandy gravel, very different from the soft material encountered a short distance to the east in Cambridgeport near the Charles River.

DESIGN OF COLUMNS

The square or rectangular columns were reinforced, in general, with about 1 per cent of longitudinal steel, and ⅜-in. round hoops on 12-in. centers were used to tie the longitudinal rods together. Many of the columns receive lateral thrusts from the arched ceilings. These were strengthened either by increasing the size, by adding longitudinal steel, or by using a rich mix so that the combined stress in the concrete due to direct load and bending would not exceed the amount specified for compression on extreme fiber.

In the case of the columns at the sides of the Romanesque Hall, where there are four columns in each bent, the thrust was divided between the 14-in. square and the 12-in. square columns in proportion to their moments of inertia, as the pair of columns on each side are well tied together and must both deflect laterally the same amount. The four columns supporting the small dome over the entrance to the Romanesque Hall receive equal thrusts in two directions parallel to the faces of the columns. Here the thrust in one direction was combined with half the vertical load on the column and the result doubled to obtain the maximum stress.

The columns were calculated to withstand the bending caused by wind pressure on the skeleton framework, including the roof, during erection. The wind load on the finished building will be much greater than the above, but it was assumed that the enclosing wall would sufficiently assist the columns to carry this extra loading.

FLOOR AND DOME DESIGN

For the long-span floor construction in the galleries and loft floor use was made of the form of T construction known as the Kahn flore-tyle system, in some cases the metal forms being replaced by terra cotta blocks, especially where a plastered ceiling was required. Part of the loft floor was designed in the usual manner with slabs and T-beams built of reinforced concrete.

The dome at the entrance to the Romanesque Hall and the groined arches in the rear of the Gothic Hall were framed by means of curved ribs, with thin reinforced-concrete slabs filling the spaces between them. The ribs were designed as ordinary arches. The barrel vault forming the ceiling over the Romanesque Hall was treated in much the same manner, the ribs being constructed first, the 4-in. curved slab being poured later and attached to the ribs by ⅝-in. curved anchor rods, which were left projecting from the sides of the ribs.

It will be noted that this ceiling is entirely separate from the loft floor above, so that each may deflect independently, the ceiling alone exerting thrusts on the columns. The ribs were of such a form that a line of resistance could easily be drawn within the mid-third zone, although a moderate amount of reinforcement was used in the ribs to tie the work together thoroughly. The short-span barrel vaults which form the ceilings under the galleries of the Romanesque Hall were figured as ordinary arches, carrying their own weight only, the curved reinforcing rods being placed in the middle of the 4-in. slab so as to resist bending in either direction.

DOUBLE DIAGONAL FLOOR GIRDERS

The two floor girders which support the square tower extend diagonally from corner to corner of the larger square below, intersecting each other at the center of the tower. These girders were assumed to act entirely independently of each other, each carrying two columns and its proportion of floor load. This asumption is evidently realized as far as the symmetrical vertical loading is concerned, because being tied together at their center lines they must both deflect equal amounts, and being of identical construction and loaded alike they will both tend to deflect equally so that neither girder will bring an additional load upon the other.

In regard to the unequal loads on the columns which these girders carry, caused by horizontal wind forces acting on the tower above, the same assumption seems to hold true. If we take first the case of wind parallel to the side of the tower, assuming a neutral axis at the central plane of the tower, each girder will be loaded with an upward force near one end, and an equal downward force near the other end. This would produce bending in the girder, with a point of inflection at the center line of the span. There would be no deflection at the center of either girder, the bending moments being symmetrical around the center line, but of opposite sign.

Similarly if we take wind in the direction of the diagonal of the square tower, the girder at right angles to the wind will be at the neutral axis, and therefore receive no load and consequently have no deflection, while the girder in the direction of the wind will have bending of the same nature as the first case considered, but of greater amount, and this girder also will have no deflection at the center of the span.

WALL LOADS OF TOWER CONSIDERED

These two diagonal girders and the columns carrying them were among the few members in the structural frame which were considered to carry masonry walls in addition to live loads and structural concrete, due to the offset in the tower which occurs just above this stage.

A similar assumption to the above was

made in regard to the girders directly below the girders just described. These girders are exposed and divide the ceiling of the Gothic Hall into a series of squares, each panel of which was reinforced equally in two directions, one quarter of the total load being supported at each edge of the panel. Each of the four girders was figured as a simple span independent of the others.

Roof Framing

The roof framing consists of long-span slabs, 5 in. thick, in general, supported by rafters which, with the slabs, form T-sections. It was desired to leave as large open spaces as possible on the loft floor, which is to be used for storage purposes, and therefore trusses with web members could not be adopted. The rafters were designed by an arch analysis. It will be noted in the drawing that the foot of the rafter is built continuous with the floor girder directly below it. However, the bending moments in the rafters and the floor beams cause a rotation around the joint in the same direction, and therefore no allowance was made for this continuity in the design of either member, though some steel was carried around the joint to prevent cracks.

The line of resistance of the arch analysis was therefore started at the neutral axis at the springing line, which was assumed to be at the top of the triangular filling above the floor beam. In other words, the arch was assumed to be two-hinged. This analysis gave about the same results as if the rafter were considered to be a sloping beam fixed at the top and figured for a bending moment of $WL/10$, but the arch method gave a much clearer determination of the combination of bending, thrust and shear at any section.

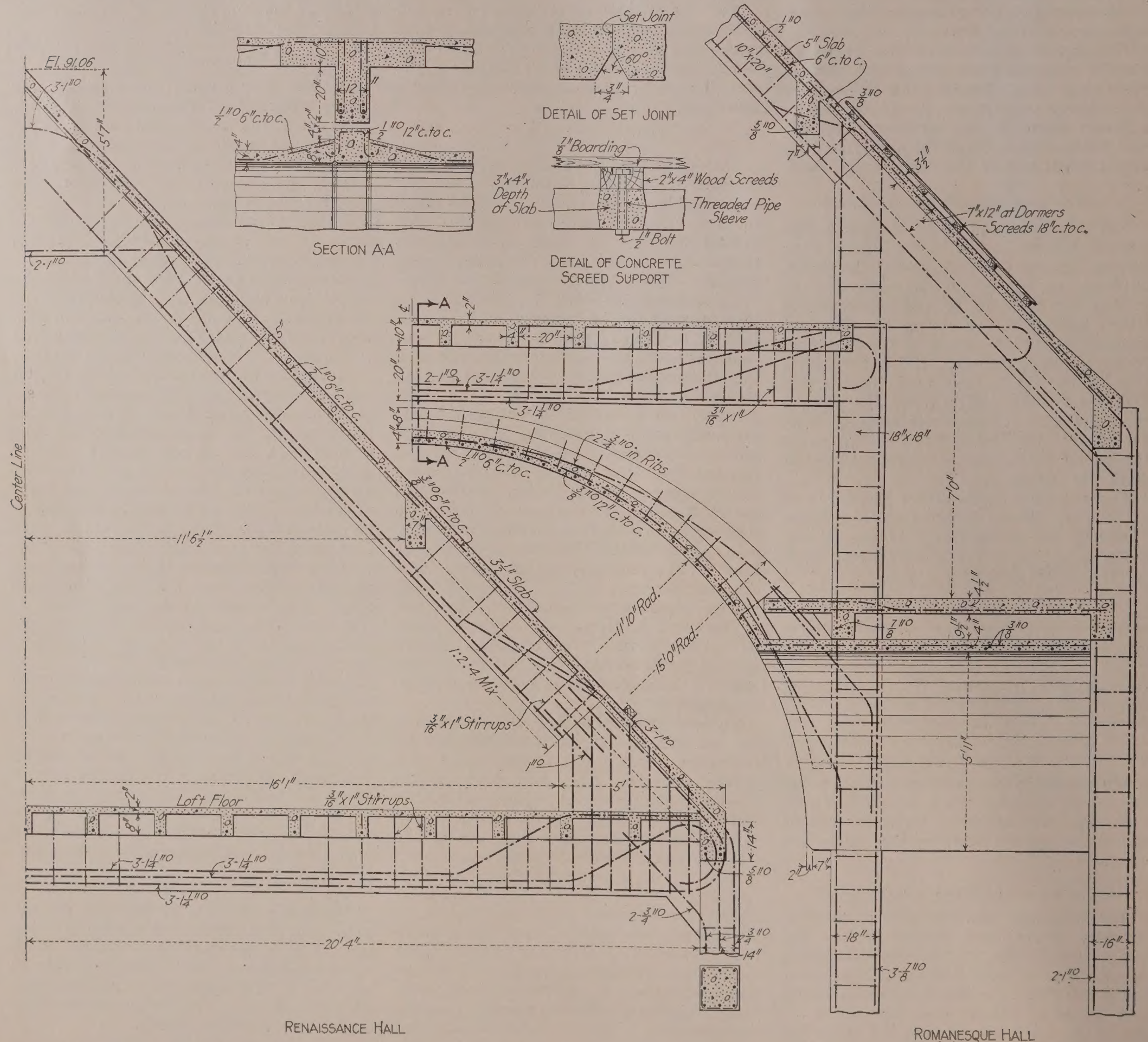
Provision for Thrust

The longitudinal thrust of the rafters was taken by rods which were placed in the floor beams, extending across the full width of building and carried out into the lower end of rafters with hooks at the ends to help develop the full tension near the ends of rods. These rods were not counted as part of the beam reinforcement.

At the lower ends of the rafters over the Romanesque Hall an exaggerated case of non-intersection of forces occurs. Here the stability of the portion outside the 18-in. square column was considered independent of its continuity with the rafter and floor beam, considering the rafter to exert an inclined thrust, the floor beam tie a horizontal pull, and the outside wall column a simple vertical reaction. At the foot of the rafter over the Renaissance Hall the depth of the floor beam was increased where connection to the column occurs by adding a triangular bracket to reinforce the web of the beam for combined shear from floor and roof loads.

Hip Construction

The rafters near the ends of wings which carry the hip beams were designed as two-hinged arches, the hips being considered to assist the arch to resist unequal loading due to wind on one side of the roof; that is, one hip was assumed to be loaded with an upward load, and the other with a downward load at the intersection with the rafter, the reactions from these loads balancing each other at the point of intersection of the hips with the ridge.



DETAILS OF RAFTERS AND FLOORBEAMS IN ROOF AND LOFT FLOOR CONSTRUCTION FOR ROMANESQUE AND RENAISSANCE HALLS

The roof purlins spanning from rafter to rafter were all made with stems vertical, largely on account of much simpler form work. Although a certain amount of T-beam action results, the roof slab forms such a sharp angle with the stem that these purlins were all figured as simple beams, neglecting the uncertainty of the slab.

Can Ground Water Be Kept Out of Sewers?

Charles P. Chase Gives Experiences Covering Quarter Century of Sewer Building in a Hundred Different Localities

EXPERIENCES during twenty-five years in sewer building in the Middle West, the difficulties encountered from the infiltration of ground water and remedies proposed were given recently in a paper presented to the Iowa Engineering Society by Charles P. Chase, consulting engineer, Clinton, Iowa. The following notes are taken from this paper:

It has been claimed by an eminent authority that when a pipe line was laid with the utmost care, with every joint perfect, wells in the vicinity became dry down to the flow line of the pipe. That such is the almost universal result the writer knows to be true, but is this pipe or sewer leakage necessarily the thing that dries the ground and wells? In sewer trenches the ground is frequently a succession of clay dikes of a more or less impervious character, crossing sand, soils and other strata, or it may be rock. These dikes hold back the water, and when cut through release the flow, which will follow the line of least resistance, now the trench, whether piped or not.

Instances of Released Flows

In one instance, in the construction of a large system, the cutting into the top layers of underlying rock was followed by an inflow of water in such quantities that it was almost impossible to work until the trench was drained. A centrifugal pump ran thirty days at the rate of about 4,000,000 gal. per day before the water level was reduced sufficiently to allow construction to proceed. The water came in on all sides and from the bottom, then followed along the new channel, the level of the ground water being lowered 10 ft. by the cutting of an 8-ft. trench, 15 to 17 ft. deep, before a foot of sewer was built. In other systems it has frequently been observed that a ditch which, when first opened, only appeared damp, had accumulated by the next morning several feet of water. The longer the trench was opened, at least for several days, the more the amount of water would increase; then, gradually, it would begin to decrease. It has also been observed that when there was practically no water flowing inside a pipe line, water has been found running outside of a pipe and even standing over it; so we can conclude that the mere opening of the trenches, in most cases, accomplishes drainage to the grade line.

Another effect of water running outside of the pipe line was cited by Mr. Chase. After a personal observation it was known that every joint was perfectly made, the inspector in one particular case having felt over each joint with his hands all around; then the joints were covered wtih dry earth and well packed. Several years afterward some portions of this line broke down because the sandy soil in which it was laid moved and washed along the outside of the pipe line to such an extent that the support was removed. In some cases the pipes settled so much that when dug up for repairs they were found 1 in. apart. Instances also were found where the cement was all gone from joints known to have been perfect and only the oakum was left, showing that the water on the outside washed the cement away before it had thoroughly set.

Bury Joints in Clay

Good results were secured on one wet job in sand by using a mortar of 1 part Portland cement to 1 part of sand, as stiff as could be worked, using this on top of well-calked oakum joints and then burying the joint by plastering over it with a waterproof, putty-like blue clay found on the job. The clay was gathered by the wagonload and a man prepared it for use.

When the trenching is in clay and care is used, fairly tight work can be secured, but the clay must be packed tightly under and around the pipe. With the new trenching machines which move so rapidly, it is found difficult to secure this proper tamping around the pipe, especially when the automatic backfiller is used, but it can be done.

The use of subdrains and tile is frequently advocated to take care of ground water and to secure tight work in the sewers, but it is a myth and a failure, according to Mr. Chase. In Massachusetts, where it was used extensively, the drain water was almost as polluted as the sewers; in other words, the leakage from the sewers descended to the drains. It is almost impossible to keep the drains open for any considerable distance in quicksand or sandy soils where there is much water, as the sand will go wherever the water will, and unless the grade is considerable, choking occurs.

Remedies

In order to secure tight work, according to Mr. Chase, we must first have the best quality of vitrified, salt-glazed sewer pipe without cracks or breaks, and laid to a true line and grade in such a manner as to give the pipe a firm bearing on the soil beneath. The joint is first to be calked carefully and fully with a gasket of oakum, soaked in neat cement of about the consistency of cream and as carefully packed as for water pipe, although of course it cannot be driven up with hammer and calking tool as forcibly as for iron pipe without the danger of breaking the pipe. The joint is then to be filled with a mortar composed of 1 part Portland cement to 1 part sand. All parts of the joint, particularly underneath, must be thoroughly filled and the mortar brought to a slight bevel outside with rubber mittens. A trowel may do the work on top, but it won't work underneath except on very large pipe and the only way the inspector can tell that the joint is perfect is to pass his hands over it himself. All water must be kept away from the joint until set. This may be accomplished either by allowing the joints to stand uncovered or by covering the cement over with a plastic waterproof clay or otherwise packing clay tightly around the pipes and joints. Ordinary soil will not keep the water back if there is much of it and sod or straw or such material sometimes used is worse than water or mud itself. In wet sand or quicksand support the pipe on boards or timbers and keep the water drawn down with pumps until the cement is set, when it may be carefully covered, making sure to pack the soil firmly around and over the pipe.

The greatest objection to the use of cement in making joints is the possibility of its being knocked out of the joint before it has become hard, washed out by water or broken open or disturbed by future movements of the pipe after it is laid. To overcome the objections to cement Mr. Chase stated that he had used at various times joint mixtures of sulphur compounds, tar compounds and asphalt, but not with much success. The sulphur compounds frequently became too hard and cracked open and were said to be inferior to cement, while the tar and asphalt compounds, Mr. Chase stated, disintegrated or dissolved. Within the past few years there have come into the market some very much improved compounds for pipe joints and with them satisfactory results have been reported in a number of cases. These jointing compounds are all to be used hot and poured into the joint similar to the lead joint of water pipe, which means, of course, that at first the calking must be absolutely tight or the jointing material will go through into the pipe. A tight gasket must be used around the joint to exclude all water when the jointing is poured, otherwise the joint is liable to blow up.

Permissible Leakage

As to the standard of permissible leakage, Mr. Chase believes that 5000 gal. per mile, suggested by several engineers as a minimum, is almost impossible of attainment, except under the most favorable conditions. As an example he noted a 10-mile system built under adverse conditions with the pipe line all below the water line. After a fairly dry season the whole system leaked 40,000 gal., or 4000 gal. per mile. In this work practically every joint was considered perfect when made, as the supervision was very thorough and strict, and every joint was watched. In the spring of the following year, however, the leakage ran up to about 200,000 gal. for a period of a week, and this has been about the variation in this system ever since it was constructed. It has been in use twenty years, has never had a stoppage and is regarded by the corporation as a perfect piece of work, but the leakage is there.

"From my own observations," said Mr. Chase, "I would not be willing to attempt to guarantee a leakage of less than 10,000 gal. per mile in ordinary soils and 20,000 gal. in water-bearing sand or quicksand, 20,000 gal. per mile being about the basis that I have usually figured on."

Grain Elevators for Australia

The wheat production of Australia is showing a constant increase, so that in normal times the production is more than sufficient to supply the home consumption, and the quantity available for export is reaching a volume of more importance every year. For several years the project of installing a system of grain elevators for the handling of wheat in bulk has been under consideration. It has now been definitely decided to install a system of elevators, and the government of New South Wales has committed itself to expend the sum of $9,733,000 for this purpose. Plans are being drawn for a terminal elevator at Sydney which will have a capacity of about 3,000,000 bushels. Later other elevators will be established at New Castle and at various railway centers to bring the total capacity up to 15,000,000 bushels.

Simple Steel Frame Supports Sidewalk Shelter

Open Waiting Station at Busy Transfer Point in City of Cincinnati to Protect Traveling Public in Rainy Weather

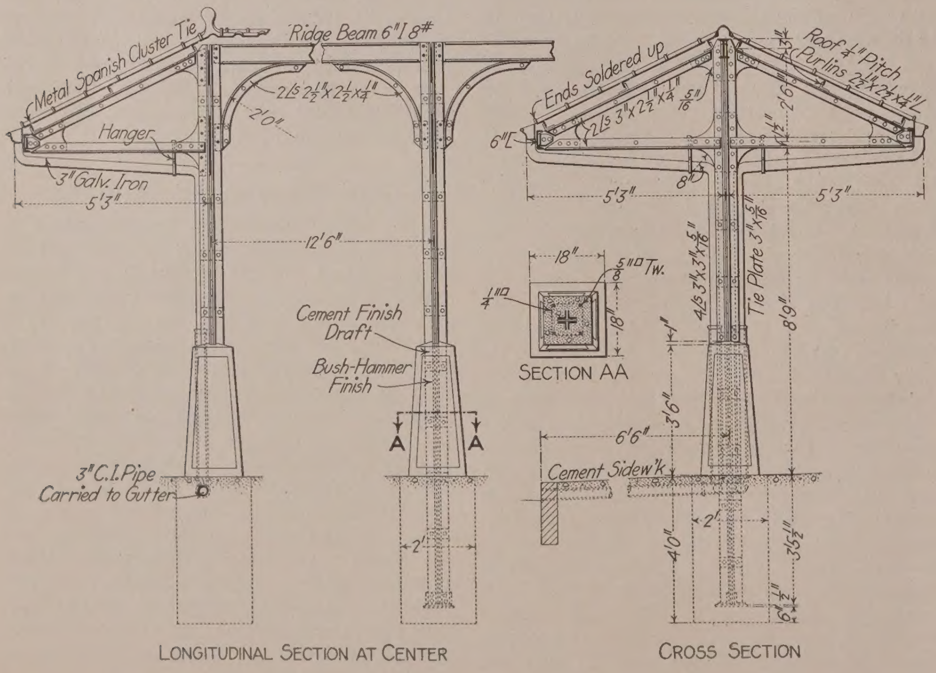
By EDGAR K. RUTH
Assistant Engineer, Engineering Department, City of Cincinnati

THE CITY of Cincinnati has recently completed a waiting station at the northwest corner of Fifth and Main Streets, the busiest transfer point in the city, and at the cost of less than $1,000 has provided a permanent improvement, which will lessen greatly the discomfort of the traveling public during both rainy and sultry weather. It has a neat appearance, requires but a small amount of sidewalk space with its single line of supporting columns, and provides shelter for at least four hundred people.

The roof is supported by one line of eight steel columns, spaced 12½ ft. apart, located 6½ ft. from the curb line and parallel to it. In plan, the roof is 10 x 97½ ft. between eave channels. The columns consist of four angles as shown in the drawing herewith, riveted back to back and anchored at a depth of 3½ ft. below the sidewalk in a 2-ft. square block of 1:2:4 concrete. Above the sidewalk the column is protected with concrete to a height of 3½ ft., the battered faces having bush hammered panels inside of smooth draft lines. Each column carries a cantilever roof truss, which supports the six lines of purlins. Ridge beams connect the tops of the columns, and eave channels connect the trusses, as shown in the drawing. Intermediate rafters, consisting of one 3 x 2½ x ¼-in. angle midway between trusses, span between the 6-in. eave channel and the ridge beam.

The roofing material is a sheet-metal imitation of Spanish tile, consisting of 28-gage sheet iron, 16½ in. wide, in one length from ridge to eave and fastened to the purlin angles by means of galvanized iron straps. A metal gutter extends around the entire roof and is connected to 3-in. cast-iron risers at the center and lower end by means of 3-in. galvanized iron pipes. The roof and gutter slope parallel to the curb at about a 1 per cent grade.

Federal officials were somewhat opposed to the construction of the station on the grounds that it would obstruct foot traffic along the sidewalk, but this has not proven to be the case.



LONGITUDINAL SECTION AT CENTER

SECTION AA

CROSS SECTION

STEEL FRAME WAITING STATION AND SHELTER OF SIMPLE CONSTRUCTION

Railway Engineering Body Adopts Wider Clearance

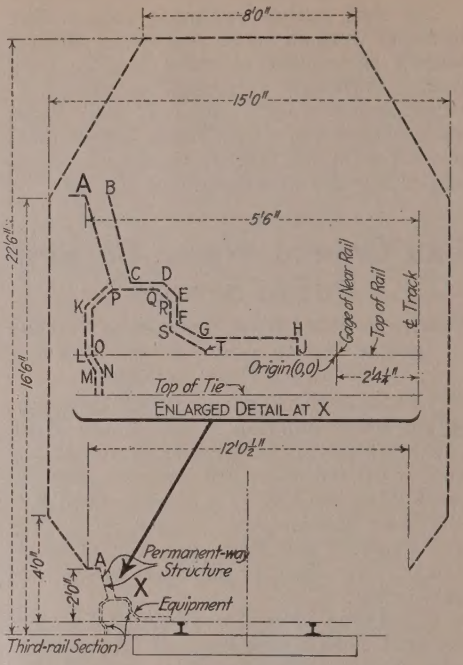
Committee Recommendations on This and Other Subjects Accepted at Seventeenth Annual Convention Summarized

AS FEWER recommendations than usual were made by the various committees of the American Railway Engineering Association at the seventeenth annual convention in Chicago last week for adoption in the *Manual*, and as a number of those made were referred back to the committee for further study, the list of conclusions formally reached by the convention is comparatively short. Probably the most notable step taken was the adoption of a minimum clearance diagram 15 ft. wide on tangent track, instead of the 14 ft., now in the *Manual.* All of the measures adopted are summarized below. Of the twenty-two committees, it will be noted that only eight figure in the recommendations adopted.

Ties.—The revised specifications for crossties were adopted with minor changes in two or three sentences. The new specifications for switch ties were also adopted.

Track.—The general plans of the typical layouts of Nos. 8, 11 and 16 double crossovers, 13 and 15-ft. centers, the typical layouts of frogs for same, and the typical layouts for Nos. 8, 11 and 16 double slip crossings with both square and staggered switch points were adopted, with certain changes in the explanatory notes proposed by the committee itself.

The typical plan of frog guard rails was adopted, with a modification to allow adjustable filler blocks. The definition of frog guard rail was adopted, as were the specifications for same, with a slight modification to permit foot guards of any sound, hard wood. The three proposed changes in the specifications for ordinary track spikes were adopted.



DETAILS OF NEW CLEARANCE DIAGRAM

Vertical and horizontal co-ordinates of points in enlarged section: *A*, 24/37¾; *B*, 24/34¼; *C*, 10⅞/31; *D*, 10⅞/25⅞; *E*, 9/24; *F*, 4 11/16/24; *G*, 2½/20¼; *H*, 2½/6; *J*, 0/6; *K*, 7 5/16/37¾; *L*, 0/37¾; *M*, —2½/36¼; *N*, —2¼/35¼; *O*, 0¼/36¾; *P*, 9⅞/33¾ *Q*, 9⅞/26⅞; *R*, 8/25; *S*, 3 11/16/25; *T*, 0⅝/19¾.

Signals and Interlocking.—Additional specifications recently adopted by the Railway Signal Association were accepted as supplementary to those now in the *Manual.*

Rules and Organization.—The clearance diagram adopted by the association is 15 ft. wide on tangent instead of 16 ft., as recommended by the committee. For the lower 2 ft. is substituted the clearance diagram prepared by the committee of electricity, and already adopted and printed in the *Manual.* The top clearances are measured from base instead of top of rail. The new diagram is here presented as the Engineering Record interprets the action of the association.

The exceptions to which the recommended clearances will not apply were all adopted, No. 6 being modified to cover all work instead of reconstruction only. The recommendation of the committee for 13-ft. track centers on tangent was adopted, and the remaining thirteen rcommendations pertaining to the clearances of specific structures were accepted on the condition that they be revised to correspond with the new clearance diagram. The six main conclusions of the committee were also adopted.

The proposed revisions in the rules of the *Manual* were all adopted.

Yards and Terminals.—The recommended definition of a holding yard was adopted.

Iron and Steel Structures.—The specifications for the protection of traffic at movable bridges published in Bulletin 178, and the three additional specifications submitted by the committee in Bulletin 181, were adopted.

Uniform General Contract Forms.—The recommended changes in the adopted agreement form were adopted as presented.

Grading of Lumber.—The new definition for southern yellow pine adopted last year by the American society for testing materials was adopted. The grading rules for hemlock lumber offered for discussion last year were adopted, subject to the changes proposed by the committee.

National Defense—For Engineer and Contractor

Fifth Article in Series Describing Military Road Building Methods and Rules of Thumb for Estimating Strength of Highway Bridges

By MAJOR P. S. BOND
Corps of Engineers, U. S. Army

WE have seen that mobility, the power to maneuver in strategical and tactical combinations, is essential to success in military operations. Roads accordingly play an important rôle in the conduct of war. In modern warfare, with the vast number of combatants engaged and the great extent of territory covered, roads are of more importance than in the past. The motor truck has come to be an important accessory to the railroad in the transportation of troops, artillery and material of all kinds, and to realize the advantages that may be derived from its use an extensive system of good roads is essential.

In road work, probably more readily than in any other branch of military field engineering, the engineer with civil training can adapt his knowledge and experience to war conditions. Military road building is not greatly different from civil practice. The civil engineer who has a thorough knowledge of the methods that produce good roads and the broad common sense which will enable him to apply them to military needs will be successful in time of war. It is only necessary that he should thoroughly appreciate the economics of warfare which we have heretofore discussed.

U. S. NEEDS MILITARY ROADS

Motor transport demands good roads and even for animal transport they are to be desired. The construction of a modern paved highway takes time and, therefore, military operations will be greatly hampered if they are conducted in a country which has not been provided in time of peace with a complete system of good roads. In many parts of Europe such systems exist, and the principal highways have been built with a view to their usefulness in war as well as in peace. The United States is poorly equipped, both as to the quantity and the quality of its roads. In any military operations conducted in our territory, extensive road construction must be carried on by both combatants. Military road work will consist very largely of the improvement, repair and maintenance of existing roads, but in many of our possible theaters of war, including the United States and other parts of the American continent, extensive new construction work will also be necessary.

Photo. Underwood & Underwood

WHILE THE USE OF ELABORATE CONSTRUCTION PLANT FOR ROAD BUILDING IS LIMITED NEAR THE FRONT THIS IS NOT THE CASE BEHIND THE LINES, WHERE PRISONERS CAN BE EMPLOYED

In the location and construction of a military road the peculiar economics of warfare, which have been heretofore mentioned, should be kept constantly in mind. In the construction of a civil road or railroad the amount of money which may be profitably expended in reducing grades, securing good alignment and in paving (in the case of a road) is determined from the estimate of the nature and amount of the probable traffic. In military construction the element of cost is of secondary importance, but the question of time is paramount. The road must be opened for traffic in the least possible time. Nevertheless, the nature and amount of the traffic and the period during which the road will probably be required are not, of course, entirely disregarded. The road will usually be constructed to meet the exigency of the moment and may later be altered and improved to meet the development of the situation.

Common labor will ordinarily be plentiful, but often no plant at all will be at hand. Wheelbarrows can usually, although not always, be supplied, and for extensive work plows and drag or wheel scrapers should be obtained. Explosives will be available and may be liberally employed. The use of more elaborate plant, such as graders, steam shovels, etc., will seldom be either practicable or advisable under wartime conditions. The stretches of road to be constructed will usually be relatively short and built to connect existing roads. Motor trucks will be utilized on the good existing roads where they can move at the relatively high speed which is necessary if their economical advantages are to be realized. But on purely military roads built under service conditions most of the traffic will be by wagons drawn by horses or mules. Four and six-line teams may be and are employed in military operations when civil economics would demand two-line teams. Also, military traffic moves in trains, and teams may be doubled up and loads shifted when necessary. Extra teams and relay stations may be provided. Such traffic moves but slowly on the best roads, and hence the greatest improvements in the road will effect only slight changes in the speed of transport—though they may reduce its cost—unless motor trucks be substituted for wagons. A rough surface, if firm, is of little disadvantage to slow-moving traffic, and the same is true of poor alignment, though of course very sharp curves should be compensated by widening the road.

ROADS BEST SUITED FOR ARMY TRAFFIC

Brick roads are, of course, out of the question, except possibly along the main motor routes on the lines of communication. For wagon traffic their advantages are not sufficient to justify their cost and, more particularly, the time required for their construction. Even common waterbound macadam can seldom be advantageously employed. The military road will usually be a common earth road. If the soil is very sandy it may be mixed with clay for a wearing surface, and conversely. Gravel may occasionally be used to good advantage if it can be obtained along the line of the road. Pit gravel usually compacts very satisfactorily under traffic if shaped up occasionally. Stream gravel usually requires the addition of a binder. If the gravel contains many large pebbles or stones it should be screened. If stone is available a rock fill, covered with a layer of earth, may be employed at soft spots where the drainage is bad. In swampy or poorly drained ground a plank or "corduroy" road will usually be the simplest and best expedient. The logs or poles are seldom covered, and the surface, while rough, is firm and suitable for slow moving traffic. A great variety of materials may be used to temporarily increase the supporting power of a road bed, including branches of trees, bunches of brush, grass, turf, leaves, etc.

The advantages of very low gradients

Photo. Press Illus. Co.

GERMAN ARMY ENGINEERS BUILT MANY LOG ROADS OVER SWAMPY GROUND IN RUSSIA

cannot be fully realized unless a good surface is also provided, and, conversely, the advantages of a good surface cannot be fully realized unless the grades are held down. Accordingly, it is of little use to strive for very low grades on a road which is not to be paved, or to incur great expense of time and money in providing a macadam paving on bad grades. A good macadam road must have low grades. Also, for slow moving military traffic neither low grades nor good surfaces are as advantageous as for motor transport.

ROADWAY WIDTHS AND GRADES

Military traffic moves in trains, and its use of the road may be regulated. Loaded wagons generally move in one direction only and empties in the opposite direction. Under these conditions a 10 or even an 8-ft. width of road may be made to meet requirements, passing points being placed at the necessary intervals and where the extra width may be cheaply provided. Such a narrow road would of course be very unsatisfactory for unregulated civil traffic with loaded wagons passing at random in both directions and meeting at all points. A width of 16 ft., which permits the easy passage of two lines of wagons in opposite directions, is desirable if it can be obtained without excessive excavation. It will seldom be advisable to provide more than an 8-ft. width of metal if the road is to be paved.

In the location of a military road the foregoing facts must be borne in mind. In order to reduce the excavation to a minimum the road should lie close to the natural surface of the ground, even if this results in occasional steep and adverse grades, poor alignment and consequently increased length. Heavy cuts and fills, with the great yardage and the relatively long hauls which they involve, should be avoided. A gradient generally not exceeding 4 to 5 per cent, with occasional short maximum stretches of 6 to 7 per cent, may be regarded as quite satisfactory for military wagon transport if better grades cannot be secured without excessive labor. A road having a grade generally not exceeding 8 per cent with occasional slopes of 10 or 11 per cent, or even more, will be practicable, but will require relaying if the distance be considerable. It may be adopted if the nature of the terrain does not allow better natural grades.

Adverse grade should, of course, be avoided, even if this requires more distance. In the original location an effort should be made to keep the grades generally as moderate as the nature of the terrain will permit without excessive excavation, and to concentrate the steeper grades in a few localities. The road is thus opened up and the bad grades may later be reduced if necessary by cuts and embankments. By thus concentrating the unfavorable grades in a few localities subsequent improvements may be effected with the least possible relocation and interruption to traffic. Thus, if there is a possibility that the road may be used for transport for a considerable period, it will usually be better to adopt a general grade of about 4 per cent, with occasional sharp maximums of 8 to 10 or even 12 per cent, rather than a general grade of 7 to 8 per cent with nothing exceeding this. In the former case a few relocations in the maximum sections, involving perhaps some heavy excavation, will eventually produce a good 4 per cent road, whereas if the steeper general grade were adopted, complete relocation and reconstruction would be necessary to produce the same result. In the first instance the heavy work is avoided by a steep climb or a detour, which is later eliminated and abandoned. Thus the locator should consider what may eventually be required and so plan his original location as to enable the ultimate requirements to be met with the least possible reconstruction, even at the cost of temporary disadvantage in the way of occasional very steep grades. If the future requirements are uncertain it may be advisable to adopt a somewhat higher general grade, suited to the nature of the terrain and to avoid steep maximums greatly in excess of the general grade. It will be apparent that the problems of the military locating engineer are not greatly different from those of his civilian confrère. He must consider the demands of the immediate situation and meet them promptly, but so far as practicable he should also give consideration to the ultimate requirements. In locating a road for military purposes the engineer enjoys one advantage in that he is not hampered to so great an extent as the civilian by questions of right of way, property values, etc. As in all military construction, first cost gives way to speed, which often simplifies the problem.

LOCATION FROM MAP

The general location of the road is selected from a map, if one suitable for that purpose is available. The next step is a hasty reconnaissance or preliminary survey to fix the general location on the ground, determine the grades which may be obtained and the special difficulties to be encountered, the materials available along the route, etc. For this examination very simple instruments will serve—an aneroid barometer for elevations, a hand clinometer to measure gradients, distances measured by pacing. A rough sketch of the route should be prepared, and it should be marked out by placing flags (pieces of red cloth on sticks), blazing trees, etc. The detailed location may be satisfactorily executed with the same instruments in the hands of skillful and experienced men. A light transit with a vertical limb and a tape or stadia rod are better, and will usually meet the requirements.

The removal of trees, especially their stumps, is a slow process, and it is therefore well to avoid timbered areas if practicable. Also, the absence of sunlight and poor ventilation increases the difficulty of maintaining an earth road in a wood in passable condition. If it be necessary to pass through a wood the road may be curved or zigzagged to avoid the very large trees. The best way to remove a large tree is to dig around it, cut the larger roots and then pull over the tree with blocks and tackle. This removes tree and stump. If stumps are encountered they can be re-

Photo. Underwood & Underwood

SOME OF THE BIG GUNS CANNOT BE TRANSPORTED ON ORDINARY ROADS; THEY REQUIRE SPECIAL RAILROAD TRACK CONSTRUCTION moved only by explosives, which may be used liberally to save time.

For military purposes a wooden trestle or viaduct, which may be constructed in a few hours or a few days, is often preferable to a long high embankment which may require weeks to construct with inadequate plant, and will generally also have to be paved in some manner to render it passable. Skill in location will reduce the number of culverts required, often it is true, at the expense of alignment. The road should follow the high ground or ridges, and the side ditches may be led off into adjacent ravines. Also, sun and air are very important aids in the maintenance of an earth road. Culverts when employed should be of the simplest type, plank and corrugated iron pipe being the most suitable materials and sufficiently durable for military purposes.

FOR MILITARY PURPOSES A WOODEN TRESTLE OR VIADUCT, WHICH MAY BE CONSTRUCTED IN A FEW HOURS, IS OFTEN PREFERABLE TO A LONG, HIGH EMBANKMENT

DRAINAGE IMPORTANT

The bearing power of a road surface depends upon the paving and upon the drainage of the roadbed. Military roads will seldom be paved and, accordingly, particular attention should be given to drainage. Subdrainage will usually be impracticable, but ample side ditches should always be provided, except in very dry climates. The material from the ditches is used to raise and crown the roadbed. The best form of ditch is one wide and shallow rather than narrow and deep, since it is more easily constructed and kept open. Such a ditch may be constructed with a drag scraper, with a plow to loosen the earth. If the road is constructed on a steep side-hill surface or intercepting ditches may be provided to keep the water from the hillside off the road. Retaining walls should be avoided if possible, as they require much time to construct. Zigzags or switch backs may be employed to save labor on sidehill work. Retaining walls if used are built of log cribs, dry rubble, etc. Concrete will seldom be employed.

One of the economic advantages of a well paved road from the civil engineer's point of view is the decreased cost of maintenance during a period of years. We are realizing more and more that increased first cost and longer time required for construction are usually economical for permanent roads in view of the lower maintenance charges and the greater satisfaction from the use of the road, the beneficial effects on the growth, the business and social life of the communities affected, etc. But we should also realize that from a military point of view these considerations have little weight. The army does not expect and does not demand that good roads shall be built under war conditions in the theaters of actual conflict, and, moreover, it cannot brook the delay that their construction would require. Prompt results are demanded, cost is disregarded and makeshifts cheerfully accepted.

As military roads are often used for a very short time only and never beyond the end of the war, the question of maintenance over a period of years does not arise. It will be economical to build an inferior road in the first place and to keep it passable by relatively expensive maintenance measures during a relatively short period. Earth roads to be passable must be kept drained and free from ruts, and for military roads ample labor for maintenance will generally be available. The roads should be kept shaped up, ruts filled, ditches kept open. The most efficient method of maintaining earth roads is by dragging, supplemented by hand labor.

EXAMINATION OF BRIDGES

An important problem with which the military engineer will often be confronted is that of determining the supporting power or safe load of an existing bridge, and the methods that may be adopted to strengthen the structure. Good civil practice has resulted in the adoption of type plans for the various forms of bridges, the safe loads of each being carefully specified. Commercial traffic is usually heavier than that which accompanies the mobile army, and, accordingly, a well designed bridge may generally be pronounced safe for military use, provided an examination shows that it is in good condition. Also the factor of safety may, in such a case, be reduced from 5 or 6 to 2½ or 3, if this be necessary. But in our country we encounter many bridges which are not designed in accordance with good practice. Many of them are not designed at all, and in many steel bridges economy of material is carried to an extreme, the designers trusting in Providence that the bridge will never be tested to the specified loading.

The quickest method of determining the carrying capacity of a bridge is by comparing it mentally with other similar bridges whose capacity is known. This will require considerable experience and great power of observation on the part of the engineer. To calculate accurately the carrying capacity of a bridge may be a tedious operation, but approximate methods or "rules of thumb," which any competent engineer can devise for himself, will usually give results sufficiently close for practical purposes.

CONVENIENT RULES OF THUMB

An examination of the bridge by an experienced engineer will usually serve to indicate the weakest or critical parts of the structure, to which special attention should be given. A useful formula for bridge stringers of wood, such as are often encountered, is the following: Safe center load in pounds times span in feet equals $A \times BD^2$. In this formula A is a factor depending on the kind of wood, and B and D are the breadth and depth of the stringers in inches. For a factor of safety of 3, A may be taken as at least 100, even for rather poor timber. Hence, if a wooden stringer is to be safe, BD^2 should equal the span in feet times the center load in hundredweights, $BD^2 = LW/100$. The weight of the beam itself may be disregarded. The safe uniform load may be taken as double the safe concentrated center load. If the deck is sufficiently heavy the equivalent center load on any one stringer should not exceed about 30 per cent of the weight of the army wagon or artillery carriage. Under this assumption the rule gives the following: For loaded wagons or light artillery, $BD^2 =$ or $> 20 \times$ span. For heavy field artillery, 4.7 in. guns, $BD^2 =$ or $> 30 \times$ span. If the span is less than 15 ft., the span multipliers may be reduced one-third.

A convenient rule of thumb for the deck, if of wood, is that the thickness of the deck in inches should be as great as the intervals between stringers in feet. Thus, if the stringers are 3 ft. apart the decking should be 3-in. planking.

If the stringers are standard steel I-beams their safe loads vary approximately with the square of the depth. Also the fiber strength is about ten times that of wood. Hence the rules become, for long spans: For loaded wagons, $D^2 =$ or $> 2 \times$ span; for heavy field artillery, $D^2 =$ or $> 3 \times$ span.

These rules are but rough approximations, but they serve for practical purposes, and afford a test of the strength of the floor system. If this be safe the remainder of the bridge timbers are probably right, since good design demands this condition, and the floor system is most subject to wear and decay.

However, similar approximations may be applied to trestle caps of two-legged trestles or the roadway bearers of small truss bridges. Assuming the weight of a bay with its load at 20,000 lb., we have, $BD^2 =$ or $> 100 \times$ length of caps; or for steel I-beams, $D^2 =$ or $> 10 \times$ length of beam. For spans of less than 15 ft. the multipliers may be reduced by half.

The strength of simple Howe or Pratt trusses may be quickly determined by the well known method of shear and chord increments.

These rules are applicable to structures which closely follow standard design for the types considered and to the usual loads with the army. Any bridge which exhibits a radical departure from the usual designs should, in the first place, be looked upon with suspicion and, in the second place, should be examined with more than ordinary care. If unusual loads are to be brought upon the structure a more thorough examination is, of course, demanded.

If the deck planking is thin, worn or decayed, longitudinal planks may be laid under the wheels. A weak stringer may be braced by placing a post under its center, or a trestle or crib may be inserted at the center of the span, which supports all the stringers. Sometimes it will be easier to take up the flooring and insert additional stringers. If trestle legs are over 10 or 12 ft. in length they should be cross-braced, and if the spans are over 15 ft., the trestles should be braced longitudinally. Wooden trusses may be strengthened by spiking or bolting additional timbers to the chords and inserting web members of timber. A weak steel truss may be supported by one or more trestles or cribs inserted beneath.

These are but a few of the expedients that will suggest themselves to the resourceful engineer. It will usually be easier to bolster up an old bridge than to build a new one. A bridge which has been examined or strengthened should be placarded to indicate its safe load.

[*Next week Major Bond will describe methods of military reconnaissance, map-making and surveying. With the huge extent of modern battlefronts, maps are a commander's chief reliance in planning his campaign.*—EDITOR.]

Pig-Iron Production in 1915 Greatly Exceeds 1914 Figures

THE PRODUCTION of pig iron in the United States for the year 1915 reached a total of more than 29,900,000 tons, which is only about 1,000,000 tons less than the previous high record of 1913, and is an increase of 28.2 per cent over the production of 1914. All grades except forge iron, which decreased about 12 per cent, show an increase over the previous year. The following table, abstracted from Special Bulletin 1 (1916), of the American Iron and Steel Institute, gives the production of pig iron by grades from the years 1910 to 1915 inclusive.

All pig iron and ferro-alloys are included, whether made in blast furnaces or in electric furnaces. Pig iron made with bituminous coal is included under coke pig iron. Pig iron made with mixed anthracite and coke is included in anthracite pig iron. Pig iron made with coke and electricity is included in coke pig iron; that made with charcoal and electricity is included in charcoal pig iron. Low-phosphorus pig iron, that is, iron running under 0.04 in phosphorus, is included in Bessemer pig iron. Pig iron containing from 0.04 to 0.10 per cent of phosphorus is classified as Bessemer. The figures for 1913 and subsequent years include under basic iron a small quantity of charcoal iron of basic grade. In 1912 and prior years charcoal pig iron of basic quality was not included in the basic production. Nearly all of the charcoal iron is classed as foundry pig iron. Ferro-silicon is included in foundry pig iron. Pig iron containing 7 per cent or over of silicon is classified as ferro-silicon. Under "all other grades" are included white and mottled iron, direct castings and miscellaneous ferro-alloys, including ferromanganese and spiegeleisen.

PRODUCTION OF PIG IRON BY GRADES, 1910-1915—GROSS TONS

Grades	1910	1911	1912	1913	1914	1915
Basic	9,084,608	8,520,020	11,417,886	12,536,693	9,670,687	13,093,214
Bessemer	11,245,642	9,409,303	11,664,015	11,590,113	7,859,127	10,523,306
Foundry	5,260,447	4,468,940	5,073,873	5,220,343	4,533,254	4,864,348
Malleable	843,123	612,533	825,643	993,736	671,771	829,921
Forge	564,157	408,841	469,183	324,407	361,651	316,214
All other	305,590	229,910	276,337	300,860	235,754	289,210
Total	27,303,567	23,649,547	29,726,937	30,966,152	23,332,244	29,916,213

Judge Construes Expression Good and Wholesome Water

Because of Failure to Comply with This Specification Judge Permits City to Operate Parallel Plant

By THOMAS A. HAYDEN
Surveyor-General's Office, Phoenix, Ariz.

A DECISION, which is of interest to engineers and those connected with the design, construction, or operation of waterworks, is that handed down on Feb. 10, at Santa Fé, New Mexico, by U. S. District Judge William H. Pope, in the case of the Raton Waterworks Company vs. the City of Raton, the decision being in favor of the latter.

GENESIS OF SUIT

The suit in question was one of the outgrowths of the effort by the city to build and operate its own water-supply plant; an effort induced by the unsatisfactory service given by the waterworks company, and timed so as to make the municipally owned works available just before the expiration of the company's franchise. In pursuance of this plan, in July, 1915, the city had completed to the point of readiness to furnish water for domestic use and fire protection an entire new storage, filtration, supply and distribution system, paralleling the old plant, and proceeded to put the same in operation as fast as connections could be made.

The waterworks company immediately procured from the federal court a temporary injunction restraining the city from entering into competition with the said company in the operation of a water-supply system, until the expiration of its franchise; which, by the terms of the ordinance conferring it, granted the waterworks company the exclusive right to operate such a system for a period of 25 years from July 25, 1891. In August, 1915, the city council formally revoked this franchise, the enforcement of which ordinance the company petitioned the court, in a supplemental bill, to enjoin.

PROGRESS OF CASE

The trial of the case was lengthy and sensational, a rather unusual feature being the fining of the entire city administration, from the mayor, city attorney and city clerk to the last alderman, in sums ranging from $50 to $100, for contempt of court, on account of their having initiated proceedings affecting the case in another court while it was pending in the federal tribunal.

Scores of exhibits, consisting of bottles and jars of the water from the company's mains, covered two long tables. Testimony introduced by the defendant, the City of Raton, alone covered 1200 typewritten pages, being for the most part the reports of users of the water furnished by the plaintiff company. Argument at the final hearing, in December, 1915, occupied some 20 days.

"GOOD AND WHOLESOME WATER"

The point on which the case hinged was whether or not the company had failed to fulfil the obligation imposed upon it by the ordinance conferring the charter—of furnishing to the defendant and its inhabitants "good and wholesome water for domestic, manufacturing and sanitary purposes, as well as the better protection of the town from disasters by fire," failure so to do operating to make the charter based thereon liable to forfeiture.

Further than the above-quoted expression, the ordinance attempts no specification with regard to the water, and the matter of the exact meaning of the phrase "good and wholesome" was gone into at great length in the testimony and arguments by counsel, and was interpreted in great detail by Judge Pope in his opinion. The specific objections made and proved against the water in the present instance are unlikely to be of general interest, but the general principles involved, and the duties held to be obligatory on all those pretending to furnish water for such uses, are here defined with a degree of explicitness not heretofore appearing in any case of which the writer has knowledge, and in such a manner that the decision may well be followed as a precedent.

Referring to authority for interpretation of the term "wholesome," the decision of the U. S. Supreme Court in the case of Columbus vs. Mercantile Trust & D. Co., 218 U. S., 645, is quoted as defining the term to mean "clean, pure and fit for domestic use." Proceeding from this Judge Pope's opinion says:

CLEAN AND PURE

"It must be clean; that is, it must be free from color or odor as repels the appetite therefor or renders it unattractive or unfit for human uses. It must be pure, in that no germs of disease shall be present and no other foreign substance shall exist to an extent such as to make the water physically unfit. The human system demands for perfect health a certain amount of water. If the physical appearance and qualities of the water are such as to repel its use and to make the intended user suffer thirst rather than undergo the discomfort or nausea of its use, such water is neither clean nor pure, and its continued use may *NOT* be imposed upon a community."

Continuing, the opinion states that it does not have to be proved that a water company furnishes water which causes active diseases to deprive such company of its franchise. "But whether there be active diseases or not," he says, "to give the public distasteful water and thus to discourage and curtail its use is to derange the human system and break down its fortifications against diseases. . . . But the decision of the case is not put upon the ground that the water caused death. The public has privileges other than exemption from illness or death. The citizen is entitled to drink palatable water; he is entitled to have such for domestic and manufacturing purposes. . . . He is entitled to be clean—when he wishes to be."

Disposing of the contention that the objectionable features of the water were so only intermittently, Judge Pope again refers to the Columbus case, which says: "That the source of supply is at times adequate and wholesome is not enough. The wants of the public must, under all conditions, be supplied." In the present instance it is pointed out that the conditions complained of, while admittedly of an intermittent nature, still had recurred again and again at various times in each season, through a course of years up to the present litigation; and therefore could not be due to mere accidents or to imperfections in the company's system of a temporary nature only. The fault is clearly inherent in the said system, and lasting though it did through many years no successful attempt had been made to remedy it.

In the decision the city is conceded the unqualified right to operate its waterworks, and the enforcement of the ordinance revoking the company's franchise is assured, the sole concessions to the company being the award of rental for fire hydrants, and an allowance of six months' time in which to remove its property from streets and other premises belonging to the city.

Los Angeles Traffic Uses Rebuilt Highway Tunnel

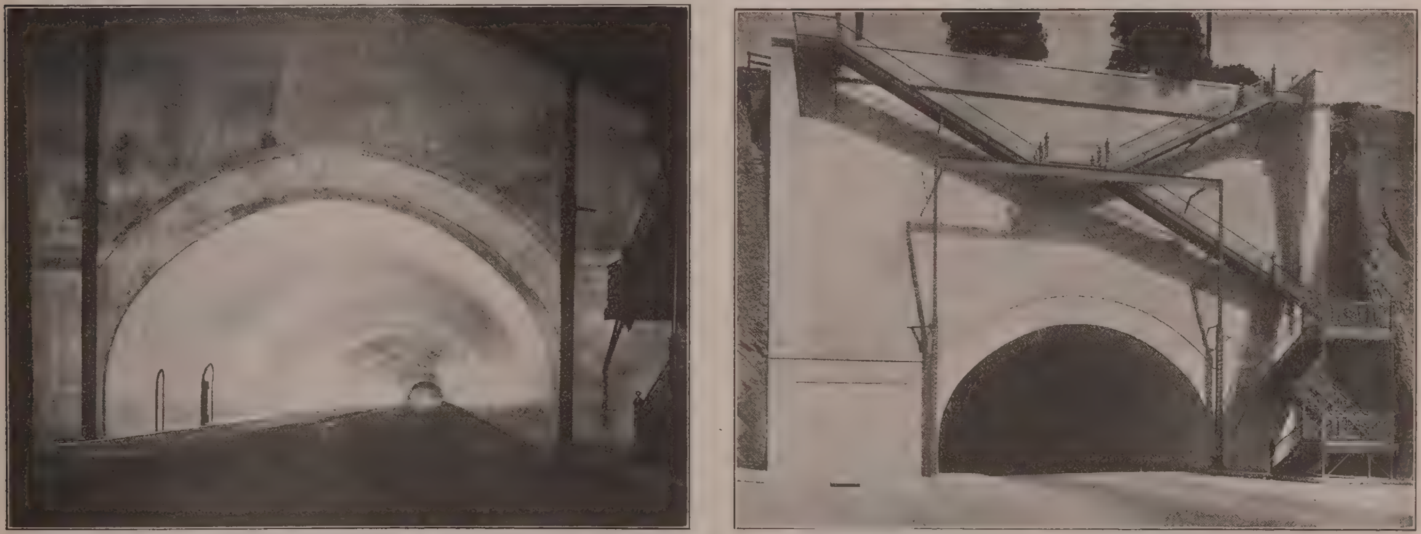
Old Bore at Steep Grade Improved by Heavy Excavation and Relining of Arch with Glazed Tile

RECONSTRUCTION work, involving a reduction in grade from 6 to 3.8 per cent, an arch relined with white glazed tile, adequate lighting and drainage facilities, and a lowering of portal levels by heavy excavation, has converted the North Broadway tunnel in Los Angeles, formerly avoided by traffic, into a much used highway route between the business district and residential sections on the outskirts of the city. The original tunnel was built in 1900, and recent improvements, begun last April, have been completed at a cost of $300,000. At the north portal the old floor level has been lowered 3 ft., and at the south end the new level is 20 ft. below the old. This has necessitated the heavy excavation in the approach cut. The tunnel is 752 ft. long, 40 ft. wide and 22 ft. in height from floor to arch. The width and height from floor to arch in the reconstructed tunnel is the same as in the original bore.

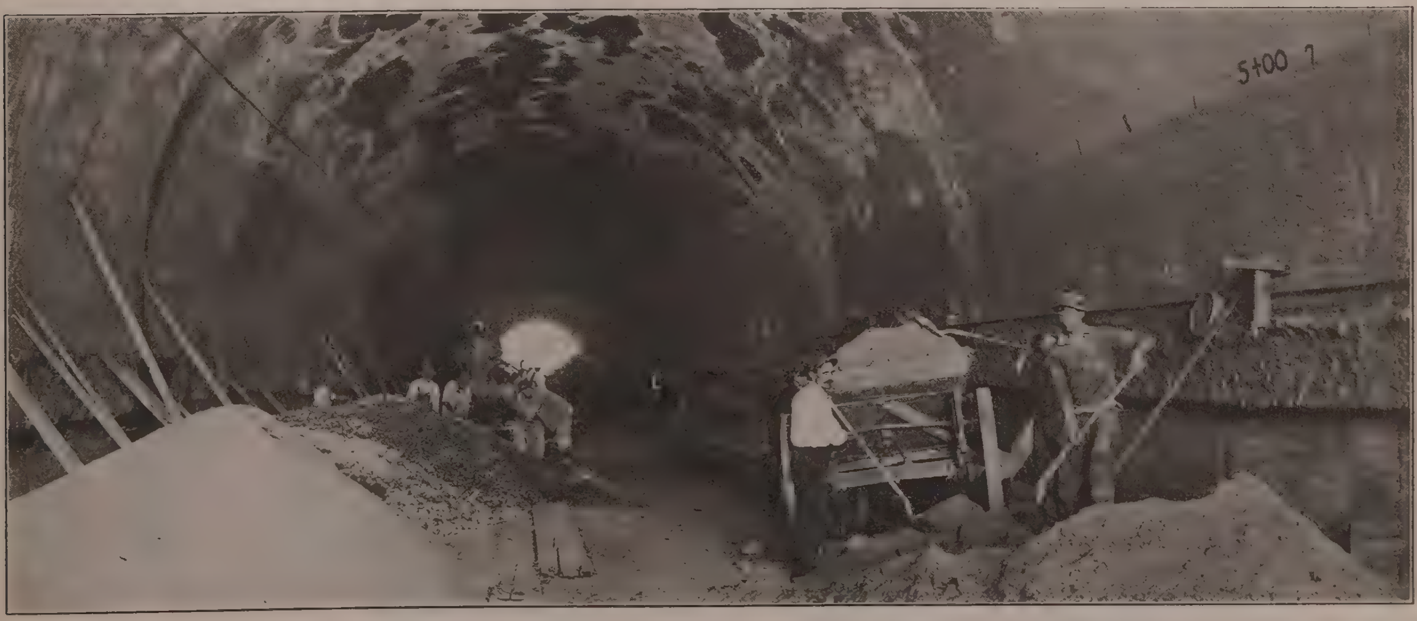
OLD FLOOR LOWERED

The first work in the reconstruction project was the excavation by steam shovel of a cut 7 ft. deep through the entire length of the tunnel which removed material to within about 2 ft. of the walls. After this excavation had been made, sections of the tunnel walls were exposed by short crosscuts, and underpinning walls 5 ft. 5 in. in thickness were built in 10-ft. sections beneath the old foundations. Beveled edge plank placed in the end of each from section before pouring the concrete formed keys which were used to interlock adjoining sections. To insure against settlement of the old structure, a rule was made that no section would be started within 70 ft. of another in which the new concrete was less than ten days old.

Some difficulty had been experienced in the original tunnel on account of the seepage which discolored the interior of the arch and rendered the tunnel damp and uninviting. Careful provision was accordingly made for adequate drainage in the re-



TUNNEL IMPROVEMENTS INCLUDED IMPROVED PORTALS, ADEQUATE LIGHTING AND GLAZED TILE LINING



NEW CONCRETE UNDERPINNING WALLS IN PLACE IN LOS ANGELES HIGHWAY TUNNEL constructed section. This was done by placing 3 in. of broken stone behind the new concrete wall below the old tunnel walls. This broken stone was placed behind sheet iron fastened to strips of wood placed vertically along the walls in such a manner that the sheet iron became the outer form for the new concrete wall.

The construction of the new arch leaves a vacant space between the two arches, varying from 3 ft. in height at the north portal to 20 ft. at the south end. This space has been found convenient for carrying conduits of various public utility companies and for tunnel lighting leads. In this space drainage is provided for any seepage that comes through the old arch and the space is ventilated by means of shafts extending to the street on top of the hill.

The floor of the tunnel was paved with creosoted Douglas fir blocks, the pavement being put down in record time by the use of three 8-hour shifts. At the south portal provision was made for the installation of an elevator in case this service should be required at some later date. Sufficient space in the westerly bank was provided for an engine room and an elevator shaft. The stairway outside the portal was extended, and now has a rise of 65 ft. to the sidewalk level on Fort Moore Hill.

LINING NEW ARCH

The new arch was built of two thicknesses of brick faced on the inside with concrete in which is set white enameled tile. The brick work was advanced in two sections, work having been begun simultaneously at the north end and at the center of the tunnel. At each of these points a heavy timber truss, curved to fit a 20-ft. length of the tunnel arch, was used as a form for the brick work. Advancing the work from the two points made it possible to keep one full crew working continuously, although one day was allowed for the setting of each section before the form was moved. That is, a crew of six bricklayers and twelve helpers ordinarily completed one of these arch sections each day so that the crew worked on each section on alternate days.

The tile work was likewise carried on in two sections. Two 50-ft. movable scaffolds were used and the tile crew consisted of about 45 men, including the helpers. The reconstruction was finally completed and the tunnel opened to general traffic with appropriate ceremonies on Feb. 19.

The awards of damages in connection with this enterprise amounted to $86,645.75 and there were forty-two claimants, twenty-five of whose claims were allowed. The awards ranged from $750 to $27,500.

Lynn S. Atkinson, general contractor, carried out the work for the City of Los Angeles.

Propose Standard Plans for Heating and Ventilating Utah School Buildings

The Utah School Buildings Commission has issued to the District Boards of Education of that state a set of proposed standard plans for arranging most effectively the heating and ventilation of small school houses, particularly one-room buildings without basements. The plans provide for an encased heater separated from the school room and arranged to furnish heated outside air in constant volume to the upper portion of the room. A ventilated wardrobe and sanitary drinking fountain above the fuel box are provided for.

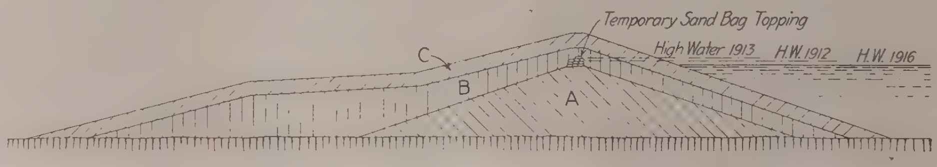
Mississippi River Flood Records Studied with Relation to Levee Grades

By Raising Embankment Elevations 6 to 7 Feet Menace from Extreme High Water Would Be Effectively Removed

By A. L. DABNEY
Consulting Hydraulic Engineer, Memphis, Tenn.

From his analysis of the Mississippi flood records of 1916 and previous years, Mr. Dabney concludes that it is now possible to fix, within narrow limits, the grades at which the levees will safely hold the largest volume of water that has ever passed Cairo, Ill. These grades, he states, should be established 4 ft. above the maximum profile indicated by his predicated gage readings. This will mean the raising of all levees an average of 6 or 7 ft. With this margin, he believes, there will result almost certain security in case of a recurrence of the flood of 1913.—Editor

THE crest of the 1916 Mississippi River flood has passed into the Gulf and has become history. This, even more than the comparatively recent disastrous floods, has brought valuable lessons to levee engineers on the lower Mississippi. It has established, or verified, the relations between several river gages, and has again demonstrated that levee districts with sections smaller than standard could hold their entire fronts against a higher flood plane than they had before experienced.



COMPARATIVE SECTIONS OF LOWER MISSISSIPPI LEVEES

1916 FLOOD MAKES RECORD

Excepting the floods of 1912 and 1913, the 1916 flood was the highest of record at Cairo. It was the highest of record, without exception, from above Arkansas City to below Natchez, Miss., a distance by river of at least 300 miles. It was held between levees without a break from Cairo to 65 miles below Helena, Ark., a distance of 370 miles. With higher stages than ever before recorded, it was held between levees from the mouth of Arkansas River to about 40 miles below Vicksburg, Miss., a distance of 240 miles. With only one break in the main Mississippi River levee that flooded a considerable area, and two minor breaks that flooded less than 50 sq. miles additional area, this flood passed between levees from Cairo to New Orleans, a distance, by river, of 950 miles. It has again forcefully demonstrated the efficiency of the Mississippi River levees.

Beginning at a comparatively low stage on Jan. 22, the Mississippi River rose rapidly at St. Louis, culminating in a crest on Jan. 31 of 31.2 ft. on that gage. In the latter part of December, 1915, and during January, 1916, there were general rains in the Ohio valley, causing the Ohio and its tributaries to rise. The stages reached by the Ohio were not excessive, but the Ohio crest, nearly meeting the crest from the upper Mississippi, resulted in the high stage recorded at Cairo, where the flood culminated on Feb. 4. The crest of this flood wave reached Memphis on Feb. 9 and Helena on Feb. 11. The rise culminated on the same day at all gages from Helena to Greenville. At Vicksburg it culminated Feb. 15; at New Orleans, March 1.

1916 FLOOD COMPARED WITH OTHERS

The 1916 flood was only 1.3 ft. below the record stage of 1913 at Cairo; 3.0 ft. below at Memphis, and 1.8 ft. below at Helena. Between Helena and Arkansas City the high water profiles of 1913 and 1916 cross. At Arkansas City the river reached 56.4 ft. or 1.3 ft. above 1913 and 1.1 ft. above the record stage of 1912; at Greenville, 0.3 ft. above 1913; at Vicksburg, 1.5 ft. above 1913 and 1.4 ft. above 1897, which had never been exceeded at that place.

Between Natchez and Baton Rouge the 1916 profile again crossed the profile of record stages, and at the latter place the crest was 1.2 ft. below the record made in 1912.

The super-elevation from Arkansas City south was due to the unusual accessions from the Arkansas and White Rivers, the crests of which were timed closely with that in the Mississippi. The Arkansas at Little Rock was 5.3 ft. below the record stage of 1844 and 3.9 ft. below 1892. At Pine Bluff it was just equal to the 1892 record. In the White River at Clarendon, the crest was 1.9 ft. above the former (1890) record.

A study of the table of highest waters reveals the fact that the Arkansas City gage, a short distance below the mouth of the Arkansas River, has usually read from 0.5 below to 2.0 ft. above the Helena gage. In 1912 it was plus 1.0 ft.; in 1913, minus 0.1 ft. In 1916 this relation went to plus 3.0 ft., which had been exceeded only twice in the years tabulated—in 1892, when the record stage since 1844 occurred at Little Rock, Ark., so timed as to produce almost its full effect on the Mississippi crest, and in 1908, with a comparatively high crest passing Little Rock about three days before the Mississippi crest reached Arkansas City. It should be noted that the effect of the Arkansas River in 1908 was even greater than the table will show. The stage recorded at Helena is for a crest that passed in March. Another crest passed that gage May 27 (44.4 ft.), and it is this which should be compared with Arkansas City for June 2. In the years which show a smaller effect by the Arkansas and White Rivers on the Arkansas City gage, the crest at Little Rock was moderate, or occurred either some weeks before or (in several instances) after the Mississippi crest had passed.

REASONS FOR VARYING GAGE RELATIONS

In making such comparisons as these it is to be remembered that levee breaks have occurred during most of the years tabulated, affecting, to greater or less extent, the gage relations. Some of the large basins were practically not leveed during the earlier years shown in the table, which was compiled by the State Board of Engineers of Louisiana from Mississippi River Commission and U. S. Weather Bureau records, up to 1913, inclusive. The stages for 1916 were procured by the writer from the Weather Bureau and district engineers.

In 1882 the flood broke the levees that existed at that time and covered practically the entire valley. Along some of the basins there were no levee systems at that time. The work of building levees to exclude the floods from these several "basins" has progressed from that time up to the present. As each district has completed a continuous levee of inadequate grade—because of insufficient funds—along its entire front, this further confinement of the water has caused the flood-plane to go higher in that part of the river, any considerable flood usually causing the levee on one or both sides to give way. Even had there been more money available, so that higher grades could be adopted, there have not been sufficiently reliable data upon which to base definite conclusions as to the effect on the gages lower down of any assumed volume of water which might enter the Lower Mississippi at Cairo and be confined between levees to the Gulf.

RESULT OF CLOSING BASINS

The closing of the Upper Yazoo basin reduced the difference between the Cairo and Helena gages from about 5 ft. in 1882 and 1883 to 2.5 ft. in 1892 and to minus 0.1 ft. in 1897. The closing of the St. Francis basin reduced the difference between the Cairo and Memphis gages from about 16.5 ft. in 1882 and 16.0 ft. in 1897 to 10.0 ft. in 1907 and 8.2 ft. in 1913.

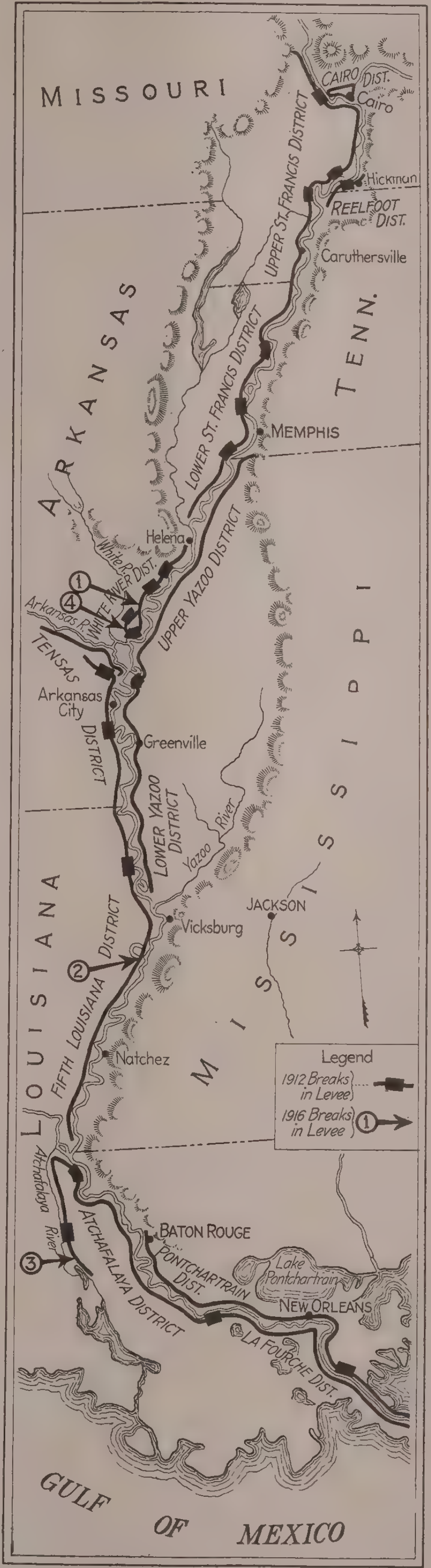
From the stage at Cairo engineers on the lower river have been able to predict fairly closely the stages to expect at their several localities, except when the "balance" has been upset by closing basins.

Levee engineers had predicted, from time to time, what the effect would be of closing some of these basins; but the taxpayers in the several districts had about as much burden as their resources would permit, and usually grades based on these predictions could not be adopted, even if they could have been accepted with positive assurance. As early as 1898, when the least difference between the Cairo and Memphis gages was about 14 ft. and the usual former difference 16.5 ft. or more, several engineers independently estimated that the closure of the St. Francis basin would reduce this difference to from 9 to 9½ ft. In 1894, when the highest stage before recorded at Arkansas City was 50.0 ft., Major William Starling, then chief engineer of the Lower Yazoo district, in a published report, predicted that a repetition of the 1882 stage at Cairo would result in a stage of 55.8 ft. at Arkansas City. It is interesting to compare these gages, in the light of history, with the above prediction. The accompanying table makes such a comparison.

COMPARISON OF GAGES WITH PREDICTION

	1882	1892	Major Starling's prediction in 1894	1916
Cairo	51.87	48.29	51.87	53.4
Arkansas City...	47.10	50.00	55.8	56.4
Difference	— 4.77	+1.71	+3.93	+3.0

In connection with 1916 it is to be noted that some water escaped through the Arkansas River levees that would otherwise have passed Arkansas City, raising that gage somewhat higher, in closer conformity with Major Starling's prediction.



LOWER MISSISSIPPI RIVER AND LOCATION OF ITS SYSTEM OF LEVEES

The smaller section in this illustration is the typical levee where breaks occurred in 1912 and 1913. In the Memphis and Helena section it is about 16 ft. high and has three-on-one slope. The relative heights of the flood planes are illustrated. Water was held above the levee tops by temporary sand bag topping. The middle section is that adopted in a district 100 miles long that has not had a break for nineteen years. The largest section is that to which 50 miles of the latter district has been enlarged since 1912.

HOW LEVEES HAVE STOOD TEST

There are about 1500 miles of levee lines on the banks of the Mississippi River below Cairo. Where the valley is very narrow between the river and the hills there are, usually, no levees, and there are, also, breaks in the continuity of the system where the tributaries enter. These tributaries are the Yazoo, on the east, and the St. Francis, White, Arkansas and Red Rivers on the west. In each case the levee line ends a short distance above the mouth of the tributary, and the flood water backs up behind it for some miles.

The Mississippi River levees, augmented by extensions up the west side of the Arkansas River and up the Red River and down the east side of the Atchafalaya, protect 25,000 sq. miles from overflow. Between the years when disastrous floods occur there are usually frequent high waters that come well up against the levees, and but for the protection which they afford would flood a large part of the protected area, bringing agricultural, industrial and commercial operations to a standstill. The levees would be worth more than their cost if they only afforded this measure of protection; but a very large proportion of the area has been protected during the most disastrous floods. In 1912 there were about 14 crevasses below Cairo, yet about 65 per cent of the entire area, or 16,000 sq. miles, was not flooded. In 1913, with higher stages at many of the Mississippi River gages, there were half as many crevasses and at least 75 per cent of the area, or 19,000 sq. miles, had effective protection. The flooded area of 1916 cannot yet be stated, but it is estimated by the writer that about 90 per cent of the 25,000 sq. miles was immune from flood water.

ONLY ONE LEVEE BREAK OF ACCOUNT

There was only one break in a levee fronting the Mississippi River that flooded a large area. This break occurred on the west side of the river, about 15 miles above St. Joseph, La. There were two other breaks in main river levees, both of minor importance, comparatively. The first is marked "1" on the map. It occurred near the lower end of the levee on the White River front, at Knowlton, Ark. The land behind this levee was already covered by backwater, and no additional land was submerged. In fact, those in charge of the district were applying their energies to more important parts of the system, and while anticipating that this levee would be overtopped and would probably break, did nothing to prevent it because of the limited damage that would result. The other break, marked 4, was still nearer the end of the White River front levee, and flooded less than 50 sq. miles at Laconia Circle.

The break near St. Joseph would probably not have submerged more than 5 per cent of the entire leveed area. The water from this break combined with flood water which came down from the Arkansas River and around the upper end of the main levee system. It was this volume which flooded the greater part of the area affected by the 1916 flood. There was only one other crevasse in the main levee system above New Orleans. This was on the Atchafalaya River (marked 3), about 4 miles from the south end of the levee, and flooded very little land. It is positively stated by a good authority that this levee was cut.

There was no break in a main levee on the east side of the river from Cairo to New Orleans, although, as stated, the river was higher than ever before for a distance of over 300 miles.

The situation that resulted in a large volume of Arkansas and Mississippi River water passing through southeast Arkansas and Louisiana, requires explanation. A few miles south of the Arkansas River Cypress Creek empties into the Mississippi. The Mississippi River levee turns westward along the south side of Cypress Creek and is extended to ground high enough to prevent moderate floods from backing round the end, but not far enough to prevent very high floods from doing so. The Arkansas River levee, entirely independent of the Mississippi River system, extends from Pine Bluff down the south bank of the Arkansas to a point near its mouth. This year there were four breaks in the Arkansas River levee and the water from these, combined with water backing up from the Mississippi between the two levee lines, resulted in the overflow which caused the most damage. The situation below the Arkansas River, and also that where the breaks occurred on the White River front, are shown approximately on the accompanying map.

While the levees generally, although of inadequate section, held the 1916 flood, there would most probably have been more breaks, but for the vigilance, energy and foresight of the district engineers and the U. S. Army engineers who had charge of them, and the co-operation of citizens and contractors along the levee lines. The flood warnings by the U. S. Weather Bureau, also, have proven very reliable and a valuable aid to those responsible for the safety of levees and property.

BASIS FOR FIXING LEVEE GRADES

The most important fact demonstrated by this flood—and one which levee engineers have heretofore recognized—is that the largest volume of water that has ever passed Cairo could be held between levees of definite size from the mouth of the Ohio to the Gulf. If the levees are built to grades that can now be determined within a margin of 0.5 ft. above the Arkansas River and 1 ft. below and to the standard section of the Mississippi River Commission or of the Upper Yazoo Levee District, they will safely hold such a flood.

The maximum discharge of the Mississippi River at Columbus, Ky., a few miles below Cairo, was practically the same in 1912 and 1913, according to Mississippi River Commission observations. Including channel and overflow water, it was approximately 2,015,000 sec. ft. This discharge has never been exceeded in that part of the river. It is estimated that, had all of this water been held by the levees, it would have reached 57.0 ft. on the Cairo gage. This estimate is believed to be accurate within 0.5 ft.

The floods of 1906, 1907 and 1916, all of which were confined between levees, have established relations between the Cairo and Memphis gages and the Cairo and Helena gages, of minus 10.0 and 0.0 ft. respectively. For 57.0 ft. at Cairo, then, 47.0 ft. at Memphis and 57.0 ft. at Helena would be indicated. The 1916 crest, like those of 1906 and 1907, was not sustained at Cairo as long as have been some other flood crests, so that there may have been a slight flattening of these crests between Cairo and Memphis, and it is more conservative to estimate 47.5 ft. for Memphis and 57.5 ft. for Helena for longer sustained crests.

According to the high-water table, only twice since 1882 has the gage at Arkansas City recorded more than 3 ft. greater reading than Helena. For neither of these years did the stage in the Mississippi approximate the maximum. While a maximum flood wave from the Arkansas and White Rivers, if it should be exactly synchronized with a crest in the Mississippi, would probably make a gage reading at Arkansas City 5 or even 6 ft. greater than at Helena, such a synchronism of *maximum flood crests* in both the tributaries and the main stream is only a very remote possibility. (In June, 1908, the difference was 5.5. The Mississippi was at a moderate flood stage. The Arkansas nearer its maximum.) To place the estimate for Arkansas City at 3.5 ft. above Helena, for a maximum crest in the Mississippi, is believed to be conservative. Below the Arkansas River the only interruption to the parallelism of the 1916 profile

RECORD OF HIGHEST WATER QN MISSISSIPPI RIVER AND TRIBUTARIES FOR FLOOD YEARS, AT STATIONS INDICATED. (1882-1916)

Stream and Name of Gage Station	1882		1883		1884		1892		1897		1898		1903		1907		1908		1912		1913		1916		Highest Since 1871	
Missouri:																										
Omaha	14.50	June 28	14.20	June 28 May 25	15.90	Apr. 6	15.30	July 3	17.10	Apr. 6	14.70	July 3	14.4	June 1	17.3	July 18	19.1	July 3	18.50	Apr. 14	18.7	Apr. 7	....	....	23.60	1881
Kansas City	19 20	July 3	28 30	June 26	17.20	July 5	24 90	May 21	27 80	Apr. 17	21 50	June 12	35.0	June 1-2	23 5	July 20	30.2	June 15	23 10	Apr. 2	21.9	Apr. 16	....	....	35 00	1903
Upper Mississippi:																										
St. Louis	32.15	July 4	34.80	Jan. 12 Dec. 29	28.10	Apr. 9	36.00	May 19	30.95	May 2	27.20	May 23	38.0	June 10	28.0	July 25-6	34.9	June 20	30.70	April 6	27.2	Apr. 16-7	31.2	Jan. 31	38.00	1903
Ohio:																										
Pittsburgh	21.00	Feb. 27	26.80	Feb. 10	31.80	Feb. 6-7	22.80	Jan. 15	28.90	Feb. 24	28.50	Mar. 24	28.8	Mar. 1	35.0	Mar. 15	26.7	Mar. 20	28.10	Mar. 22	*30.4	Mar. 28	....	....	35 00	1907
Cincinnati	58 58	Feb. 21	66 35	Feb. 15	71.06	Feb. 14	43 90	Apr. 25	61 10	Feb. 26	61.40	Mar. 24	53 3	Mar. 5	65.1	Jan. 21	55.7	Mar. 11-2	53.20	Mar. 27	69.8	Apr. 1	....	....	71.06	1884
Louisville	37.40	Feb. 22	43.80	Feb. 16	46.60	Feb. 16	21.80	Apr. 23	35.30	Feb. 28	36.20	Mar. 30	28.5	Mar. 9	41.2	Jan. 22	31.1	Apr. 6	28.70	Mar. 28	45.1	Apr. 2	....	....	46.60	1884
Cumberland:																										
Nashville	55.30	Jan. 22	41.60	Feb. 14	48.30	Mar. 15	38.80	Apr. 26	49.25	Mar. 20	38.80	Jan. 23	40.4	Mar. 9	28.2	Jan. 24	29.5	Feb. 16	46.50	Apr. 8	44.9	Apr. 2	....	....	55.30	1882
Tennessee:																										
Chattanooga	40.17	Jan. 19	38.17	Jan. 23	42.83	Mar. 10	37.90	Jan. 17	37.90	Mar. 15	24.60	Sept. 5	31.8	Apr. 11	19.6	Jan. 2	24.7	Feb. 17	30.20	Apr. 5	32.9	Mar. 31	....	....	54.00	1875
Mississippi:																										
Cairo	51.87	Feb. 26	52.20	Feb. 27	51.79	Feb. 22-4	48.29	Apr. 28	51.67	Mar. 25-6	49.78	Apr. 6	50.6	Mar. 15-7	50.3	Jan. 27	45.5	Mar. 19	53.94	Apr. 6-7	54.7	Apr. 5-8	53.4	Feb. 4	54.70	1913
Memphis	35 15	Mar. 9	34 75	Mar. 6-8	34 15	Mar. 13	34 50	May 23	37.66	Mar. 20	37.59	Apr. 10	40 1	Mar. 20	40.3	Feb. 3	35.5	Mar. 24-5	45.23	Apr. 6	†46.1	Apr. 9-10	43.5	Feb. 9	†46.10	1913
Helena	47 20	Mar. 9	46 90	Mar. 8-9	47 00	May 6	45.73	May 11	51.75	Apr. 4	49.11	Apr. 17	51 0	Mar. 26-7	50.4	Feb. 5-6	45.2	Mar. 26	54.30	Apr. 22	55.2	Apr. 22-3	53.4	Feb. 11	55.20	1913
Mouth White River	48.40	Feb. 28	48.00	Mar. 9-12	47.90	Mar. 7-8	49.27	June 1	52.42	Mar. 29	51.05	Apr. 19	53.7	Mar. 28-9	51.9	Feb. 7-8	49.5	June 1-2	56.35	Apr. 16-7	55.4	Apr. 24	....	....	......	....
Arkansas:																										
Fort Smith	21.80	Feb. 23	22.80	June 11	27.90	Feb. 14	30.90	May 19	17.00	Mar. 20	35.00	May 7	24.1	May 26	18.8	Jan. 24	32.7	May 27	21.50	Apr. 2	15.0	Apr. 11	....	....	35.00	1898
Little Rock	25 70	Feb. 25	25 80	Feb. 19	30 60	Feb. 15	31 20	May 21	23.20	Mar. 21	29.30	May 11	26.2	June 2	20.4	Jan. 25	27.8	May 30	24.00	May 4	18.8	Apr. 13	27.3	Feb. 2	31.20	1892
Mississippi:																										
Arkansas City	47.10	Feb. 28	46.35	Mar. 11	46.50	Mar. 7-9	50.00	June 1	51.90	Mar. 20	51.13	Ap. 19-21	52.9	Mar. 27-8	52.1	Feb. 8	49.9	June 2-3	55.33	Apr. 12	55.1	Apr. 21-5	56.4	Feb. 10-3	56.4	1916
Greenville	41 68	Feb. 27	40.40	Mar. 9-13	41.10	Mar. 7-8	44 28	June 1	46.75	Mar. 29	46 16	Apr. 21	49 1	Mar. 27	47.3	Feb. 9	44.7	June 3-5	50.76	Apr. 12	50.4	Apr. 21	50.7	Feb. 11-4	50.76	1912
Lake Providence	38.32	Mar. 20	36.47	Mr. 11-14	38.40	Mar. 23-4	41.90	June 2	44.54	Mar. 30	44.35	Apr. 23	46.5	Mar. 27	46.3	Feb. 10	44.1	June 5	48.25	Apr. 12	48.0	Apr. 21	48.8	Feb. 15	48.8	1916
Vicksburg	48.75	Mar. 20	43.80	Apr. 7	49.00	Mar. 25	48.45	June 2-3	52.48	Apr. 16	49.40	Apr. 24	51.8	Mar. 28	49.6	Feb. 10-1	47.8	June 5-8	51.65	Apr. 12	52.4	Apr. 28	53.9	Feb. 15	53.9	1916
Natchez	47.75	Mar. 28-9	44.00	Apr. 7-9	47.40	Mar. 24-6	48.10	June 26	49.82	May 2	47.40	Apr. 26-7	50.3	Mr. 28-31 Apr. 2	48.9	Feb. 13-4	48.7	June 14	51.42	Apr. 13-7	52.4	Apr. 26-7	53.6	Feb. 15	53.6	1916
Red:																										
Fulton	....	....	....	....	....	....	34.85	May 23	28.60	Mar. 23	27.90	May 11	31.1	Mar. 14	31.4	June 4	33.9	June 2	30.62	Apr. 6	23.9	May 24	32.2	Feb. 4	35.75	1876
Shreveport	31 40	Feb. 21	25 30	Mar. 11-2	32 70	May 14	35 70	May 28	24 10	Apr. 11-3	15.00	May 21	33.1	Mar. 22	26.9	June 13	35.1	June 15	19.30	Apr. 14	12.4	May 26-7	25.5	Feb. 10	35.70	1892
Alexandria	34.85	Mar. 17-8	25.45	Mar. 27	35.20	May 30 June 1-5	38.25	June 12-3	26.25	Apr. 14-5	17.40	Jan. 25	35.0	Mar 28	32.6	June 18-9	41.8	June 6	33.56	Apr. 21	24.2	Apr. 6	36.8	Feb. 16	41.82	1908
Atchafalaya:																										
Barbres Landing	49.90	Mar. 27	46.30	Apr. 8-10	48.60	Mar. 30-1	49.70	June 27-8	50.95	May 13-4	42.35	May 2	50.5	Apr. 7-11	45.7	Feb. 19-20	48.0	June 14-23	53.35	May 10	50.2	May 10-1	....	....	......	....
Melville	37.00	....	....	....	....	....	35.00	July 2-5	35.10	May 15	33.90	Apr. 29 May 6	38.7	Apr. 4-5	37.7	Feb. 20	39.7	June 22	41.73	May 6-15	41.7	Apr. 24	43.2	Feb. 14	43.2	1916
Mississippi:																										
Red River Landing	48.50	Mar. 27	45.20	Apr. 9	47.30	Mr. 29-31	48.87	June 27	50.20	May 14-5	44.30	Apr. 28-9	50.1	Apr. 8-9	46.9	Feb. 15-9	48.7	June 14-6	53.20	May 11-2	50.6	May 10	....	....	......	....
Baton Rouge	35 95	Mar. 26	35.08	Apr. 9	36 20	Mar. 24	38 45	June 28	40 65	May 13-5	34.60	Apr 29-30	40 0	Apr. 7-8-10	37.4	Feb. 17-9	39.6	June 16-7	43.82	May 11	41.3	May 9	42.6	Mar. 1	43 82	1912
Plaquemine	31.30	Mar. 21-7	30.80	Apr. 9	31.70	Mar. 24	33.50	June 13	36.25	May 13-7	30.57	Apr 29-30	36.1	Apr. 5-7-8	33.4	Feb. 17-9	35.2	June 15-6	39.38	May 11	36.8	May 7-11	....	....	39.38	1912
Donaldsonville	....	....	....	....	25.70	Mar. 24	30.15	June 13	32.75	May 13	27.95	Apr. 28-9	32.2	Apr. 7	30.0	Feb. 15-21	31.6	June 18	35.10	May 10	32.8	May 8	....	....	35.10	1912
College Point	23.20	Mar. 26	23.45	Apr. 9	24.10	Mar. 24	25.62	June 13	27.95	May 15	23.50	Apr 27-30	27.8	Apr. 5-6	25.9	Feb. 15-9	27.1	June 17	30.18	May 11	28.2	May 7-9	....	....	30.18	1912
Carrollton	14.95	Mar. 27	15.40	Apr. 7	15.60	Mar. 18	17.35	June 10	19.17	May 13	15.90	Apr. 25	19.4	Apr. 5-6	18.7	Feb. 16	18.7	June 18	21.05	May 9	19.2	Apr. 28	....	....	21.05	1912
New Orleans	15.80	Mar. 27	....	....	16.20	Mar. 26	17.60	June 11	19.50	May 13	16.90	Apr. 27-8	20.3	Mar. 30 Apr. 1	19.8	Feb. 13-21	20.0	June 19-22	21.40	May 9	20.3	May 5-13	21.0	Mar. 1-4	21.40	1912
Fort Jackson	....	....	....	....	....	....	6.90	Mar. 31	7.20	Apr. 22-3 Nov. 14-6	6.70	Apr. 23-6	8.0	Mar. 27	8.3	Feb. 14-16-18	8.1	Feb. 14-16-18	8.28	May 3-11	8.3	Apr. 23-7	....	....	......	....

*Corrected from 34.0. †Weather Bureau Record 46.50.

This table (except 1916 column) from report of Board of State Engineers of Louisiana; compiled from Miss. River Comm. and U. S. Weather Bureau Records.

to that which should obtain for a completely confined flood, was caused by the break near St. Joseph, La. No attempt will be made here to estimate the effect on the profile of this break, nor to extend a predicted maximum profile below Vicksburg.

The writer now ventures the prediction that the future gage readings from Cairo to Vicksburg, for a confined flood equal in volume to those of 1912 and 1913 at Cairo, with such a volume from Arkansas and White Rivers, as it is reasonable to expect on the crest of a maximum Mississippi crest, as follows:

Cairo	57.0 ft.	Arkansas City..	61.0 ft.
Memphis	47.5 ft.	Greenville	55.3 ft.
Helena	57.5 ft. or less	Vicksburg	58.5 ft.

If a levee system which held the 1916 flood should be enlarged to 1 ft. higher grade it would hold 1 ft. higher water; but to do so would require much vigilant attention and entail much nerve-racking suspense. There would be as much chance of disaster. The conditions have changed on the Lower Mississippi since the early days of levee building, when an occasional levee break was a matter of course, and its principal damage was to delay for a few weeks the planting of crops. The country is much more highly developed. A levee break now floods populous and wealthy towns, oil mills and compresses and stops traffic on miles of railroads. The same chances of having levee breaks should not be taken. They cannot be afforded. Grades should be established 4 ft. above the maximum profile indicated by the predicted gage readings above. This will mean the raising of all levees an average of 6 or 7 ft. With this margin, there will result almost certain security, in case of a recurrence of the 1913 flood volume, and an excellent chance to confine to the river channel a considerably larger volume, should it ever come.

New York State Highway Maintenance Analyzed

Deputy Commissioner Sarr Reports on Last Year's Work, Involving Total Expenditure of $4,210,000

From an analysis of last year's maintenance and repair costs on New York State's highway system, involving an improved mileage of 5926 on Dec. 31, 1915, and an expenditure of $4,210,575, Fred W. Sarr, second deputy commissioner, concludes that the improved State and county highways of all types can be perpetually maintained for about $750 per mile. There are certain factors, however, which must be considered in order to understand clearly what this figure represents, and these are discussed in Mr. Sarr's annual report to Commissioner Edwin Duffey, which has recently been made public.

Summary of Work

On April 1, 1915, Mr. Sarr reports there were improved and accepted 5345 miles of State and county highways. The mileage was increased as the season advanced, and on Dec. 31, 1915, there were 5926 miles of improved and accepted highways, which have been maintained and repaired.

The following is a summary of work performed during the past season, including sums obligated on uncompleted contracts:

A study of the experience of the New York State Highway Department in maintaining and repairing highways during the past year indicates that the expenditures are divided into three groups.

First.—Maintenance, or the act of maintaining and preserving the various features of the highway in the same or uniform condition. The cost of such maintenance of all the improved highways of all types was approximately $350 per mile, which includes the cost of the patrol system and the material used by the patrolmen, together with the cost of the surface treatments with bituminous materials and cover and supervision.

Second.—Repair, or the act of restoring the highway to its former condition after more or less extensive deterioration during the winter season with the contingent freezing, thawing, unstable foundation, obstructed drainage, floods, washouts, sliding banks, etc., and that the cost of such emergency repairs was approximately $140 per mile for roads of all types.

Third.—Reconstruction and resurfacing. While on many of the improved highways it appears possible, with efficient maintenance, to preserve a standard of improvement from year to year, there are those that show marked deterioration in spite of efforts at maintenance and extensive repairs from time to time. This deterioration is generally due to peculiar traffic conditions, combined with unsuitable materials used in the original improvements, and is often the result of insufficient foundation over unstable material in the roadbed.

Summary of Work During 1915

276 miles of highway resurfaced or reconstructed, at an average cost of approximately $5,471 per mile; total expenditures and obligations under this item	$1,510,112
2086 miles of highway given a surface treatment of bituminous material and cover of sand, fine gravel, iron ore tailings, or fine crushed stone, at an average cost of $419 per mile; total expenditures and obligations under this item	874,137
728 patrolmen employed in the work of maintenance and minor repairs, at a total cost for labor........	403,047
Expended for material and temporary labor in making miscellaneous repairs and supplying material to patrolmen for maintenance	998,462
Expended for rentals of large units of repair equipment	58,135
Expended for purchase of equipment and tools	31,958
Expended for engineering, supervision, inspection and expenses incidental thereto	334,724
Total amount expended and obligated for all purposes, approximately.	$4,210,575

During the past year the mileage of resurfacing and reconstruction has averaged about 5 per cent of the total mileage of improved highways, at an average cost of about $5,500 per mile, for the mileage treated in this manner, or a charge of about $260 per mile when distributed over the entire improved mileage.

The total amount expended and obligated for all purposes in the year will average $750 per mile when distributed over the entire mileage of improved highways. This statement, however, is misleading in that a large percentage of the total improved mileage is of recent construction.

The first highways improved by the state under the Higbie-Armstrong act were completed in 1899, and in thirteen years, or to the end of 1911, there had been completed and accepted but about 2,600 miles, while in the last four years there have been completed and accepted 3,226 miles. In other words, 55 per cent of the improved mileage has been constructed an average of two years, while the 45 per cent has been improved an average of ten years.

Basis of Mileage Cost

Assuming that no pavements should require resurfacing for a period of four years after construction, it is necessary, Mr. Sarr points out, to eliminate the 3226 miles which have been improved during the past four years from the consideration of the cost per mile for resurfacing and reconstruction. Therefore, the total expenditure for this subdivision of the work should be distributed only on such mileage as has been constructed or improved for a period of four years, and when so distributed the cost per mile for this subdivision during the past year is approximately $560 per mile.

It would seem, however, that the average life of a pavement after reconstruction would be greater than that of the first improvement, as foundational weakness that had developed would be provided for in the reconstruction. The maintenance and repairs for the first five years after the original improvement are greatly increased by heavy items which are properly chargeable to improvement, and are really a completion of the improvement, such as removal of slides from banks which have been cut into at time of improvement; the construction of retaining walls to sustain such banks and for the protection of the highway from the erosion of streams. The drainage conditions, as provided in the original improvement, are often the subject of much complaint from the abutting owners and necessitate modifications and construction of storm-water sewers, all of which develop and are taken care of in the first few years, after the original improvement. It can, therefore, reasonably be expected that the cost of maintenance repairs and reconstruction will decrease in some proportion at the age of the improvement, and that the high cost of $560 per mile for resurfacing and reconstruction, when applied to all the improved highways, would never be attained, and that the reduction in the item of repair would offset the increase in reconstruction as the improvements increased in age owing to the gradual elimination of weakness, together with the effect of efficient maintenance.

It would accordingly seem by this manner of reasoning that the improved State and county highways of all types could be perpetually maintained for about $750 per mile.

New York Transit Traffic Grows Fast

The subways of New York City carried 34,032,671 passengers in January last, according to figures made public recently, by the State Public Service Commission for the First District. This represents a 13½ per cent increase over the number of passengers carried in January, 1915. At the same time the elevated lines, on several of which third-track express service was opened late last year, carried 26,471,238 passengers, as against 713,522. At the Grand Central Station 2,141,862 tickets were sold in January of this year as against 1,796,984 in January, 1915. The Brooklyn subway traffic gained appreciably, and amounted to approximately 30 per cent of the total in January. The total number of passengers carried on all subway and elevated lines for the month was 60,503,909 as compared with 55,742,984 a year previous.

Aerial Passenger Cableway of Unique Type Crosses Niagara Whirlpool

Six Constant-Tension Steel Cables Support a 3½-Ton Car with Capacity for 46 Persons—Movable Counterweights Allow Variation in Sag

A PASSENGER cableway, said to have the longest clear span in the world, has recently been built across the Niagara Whirlpool, at a cost of $60,000. The car is carried by six parallel cables, three on each side. These cables are kept at constant tension by means of counterweights at one end which adjust themselves automatically to allow variation in sag and take up any changes in the loaded weight of the car. The design is of Spanish origin, and the enterprise was organized by Spanish capitalists as The Niagara Spanish Aerocar Company, Ltd. The following description is taken from an article in *The Canadian Engineer*.

DETERMINING CONDITIONS

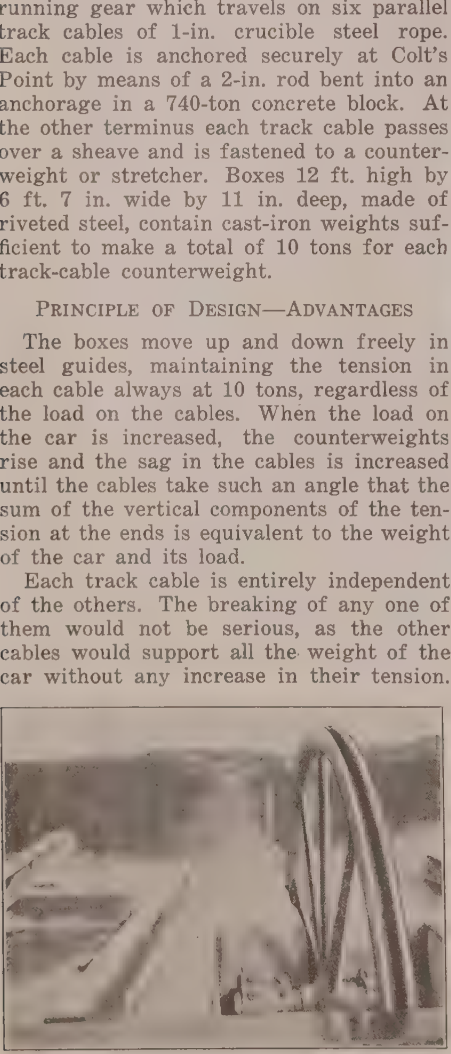
The design of the anchorages, both of which are on the Canadian side, one at Colt's Point and the other at Thompson's Point, was governed largely by the fact that the cableway was not allowed to cross the tracks of the Niagara Belt Line Railway, that the appearance of the cliffs on neither side of the whirlpool should be altered and that no towers or structures should rise above the level of the track of the railway which runs along the cliff.

The passenger car is suspended from a running gear which travels on six parallel track cables of 1-in. crucible steel rope. Each cable is anchored securely at Colt's Point by means of a 2-in. rod bent into an anchorage in a 740-ton concrete block. At the other terminus each track cable passes over a sheave and is fastened to a counterweight or stretcher. Boxes 12 ft. high by 6 ft. 7 in. wide by 11 in. deep, made of riveted steel, contain cast-iron weights sufficient to make a total of 10 tons for each track-cable counterweight.

PRINCIPLE OF DESIGN—ADVANTAGES

The boxes move up and down freely in steel guides, maintaining the tension in each cable always at 10 tons, regardless of the load on the cables. When the load on the car is increased, the counterweights rise and the sag in the cables is increased until the cables take such an angle that the sum of the vertical components of the tension at the ends is equivalent to the weight of the car and its load.

Each track cable is entirely independent of the others. The breaking of any one of them would not be serious, as the other cables would support all the weight of the car without any increase in their tension. The car would drop several feet suddenly and, after a few vertical oscillations, would assume a new position of equilibrium. Thus the breaking of one cable would not imperil the passengers,—and the breaking of two cables at the same time would be very improbable.

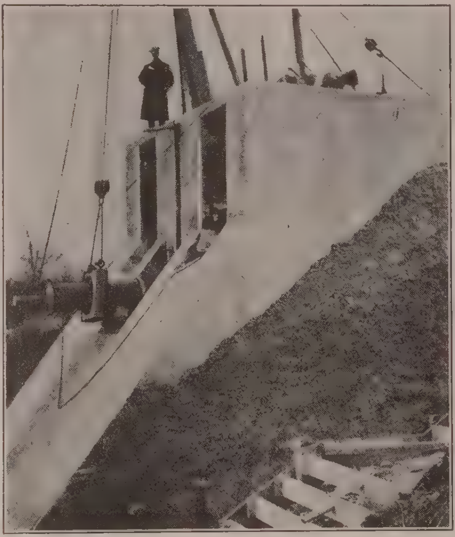


TRACTION SHEAVE AT COLT'S POINT

The car seats twenty-four passengers and provides standing room in a raised aisle in the center of the car for twenty-two more, including the conductor. The weight of the car when empty is 3½ tons, and when fully loaded 7 tons. It is 10 ft. 10 in. wide, 24 ft. long and 23 ft. high. The accompanying photograph shows the car suspended from the six track cables.

OPERATION OF CAR

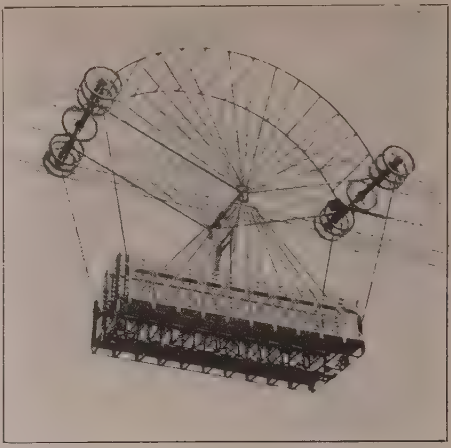
The car is propelled by a ⅞-in. plow-steel traction cable fastened to one end. This cable passes over a sheave on Colt's Point, runs back across the whirlpool, over a sheave in front of the Thompson's Point station, and to the driving sheave. From here it passes around three sheaves to one of which is fastened a 10-ton counterweight box arranged in guides similar to those for the track-cable counterweights, thus creating a tension in the cable which adjusts any slack caused by the rising and falling of the car.



COLT'S POINT ANCHORAGE—AUTOMATIC STOP

The 8-ft. driving sheave is turned by a 75-hp. Westinghouse motor, through a 30 to 1 worm gear, giving a speed to the car of about 400 ft. per minute when the controller is at full speed. The trip can be made in about 4½ min., but it is planned to permit it to occupy 6 min. by running at half speed part of the time. To provide against a breakdown of the motor or interruption in the power supply, there is a clutch in the driving shaft, by means of which the motor can be disengaged and a 5-hp. gasoline engine engaged both through a worm gear and through socket wheels.

An automatic control stop is provided in each terminal which stops the car without jar within a distance of 3 ft. 4 in. In one of the photographs the stop can be seen extending from the base of the concrete block. The traction cable runs longitudinally through the 5 in. pneumatic cylinder and through the center of the piston. A clamp on the traction cable, just ahead of the car, strikes the face of the piston and also engages with it in such manner that the car cannot slip back from the landing platform.



CAR SUSPENDED FROM SIX TRACK CABLES

ERECTION OF CABLES

After the traction and track-tower sheaves had been erected, a very long rope was carried around the face of the cliff from Thompson's Point to Colt's Point. This rope was then hoisted over the tops of the trees until it could be pulled taut from point to point. A ½-in. wire rope was pulled across with the aid of a hoisting engine, and then the ⅞-in. traction cable was pulled into place. The traction cable was used to haul the track cables across.

The strength of the track cables is 92,000 lb, each, allowing for bending over the sheaves, and the working tension is 20,000 lb., so that the factor of safety is 4.6.

The sag of the track cables unloaded is 47.6 ft.; the maximum sag when loaded with car and passengers is 100 ft. The car will still be 148 ft. above the surface of the water at the point of maximum sag. The grade of the track cables varies from 16 per cent at either landing to level at the center of the span.

The general contractors were Norman McLeod, Ltd., Toronto, on a cost plus percentage basis. The superintendent in charge of the construction was Lewis S. Roy. J. E. Taylor was resident engineer, representing Wright & Howard, consulting engineers, Toronto, who were employed by the Spanish company to adapt their design to local conditions, and who prepared the plans and supervised the construction.

Large Iron Ore Deposits in Brazil

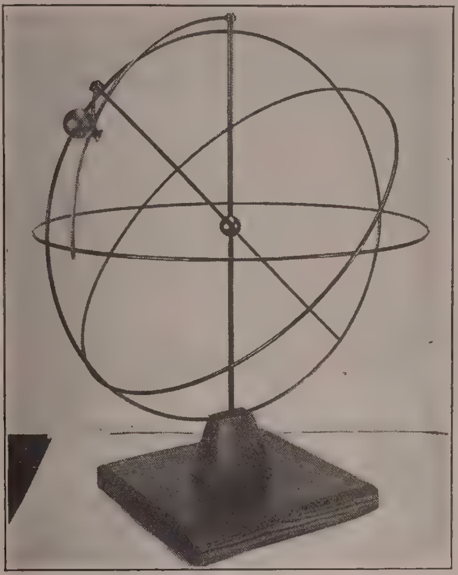
Brazil has the largest known deposits in the world of 70 per cent iron ore, practically free from phosphorus. The state of Minas Geras alone is estimated to have 1,500,000,000 to 2,000,000,000 tons about 300 to 400 miles from the sea coast, and bodies of iron ore exist in other states of Brazil, according to Percival Farquhar in an address at a meeting of the Federal Trade Council, New Orleans. Our eastern mills, whose expansion should take a new phase with our increasing export of steel and steel products, can use this ore to advantage, as well as Europe, where it will allow low-grade and high phosphorus ores to be used by mixture.

Rod Models Explain Astronomical Problems

By FRANCIS S. FOOTE, JR.,

Associate Professor of Railroad Engineering, University of California, Berkeley

THE accompanying photographs show two models recently constructed for use in teaching to engineering students the elements of practical astronomy usually included in a course in plane surveying.



UNIVERSITY OF CALIFORNIA MODEL ILLUSTRATES CIRCUMPOLAR STAR OBSERVATION

These models were constructed from sketches prepared by the writer, but all the detail of the design was worked out by Valdemar Arntzen, expert mechanic in charge of our department shops.

One model is for bodies relatively near the celestial equator, and is used principally in illustrating solar observations. The ball which represents the sun may be moved along the declination arc, showing the sun in both north and south declinations. The altitude arc slides through a swiveling socket at the "sun," so that the shape of the spherical triangle changes with the various changes in the sun's position. With this model it may be clearly shown why the sun rises north or south of east, why an observation for azimuth should not be taken near noon, etc.

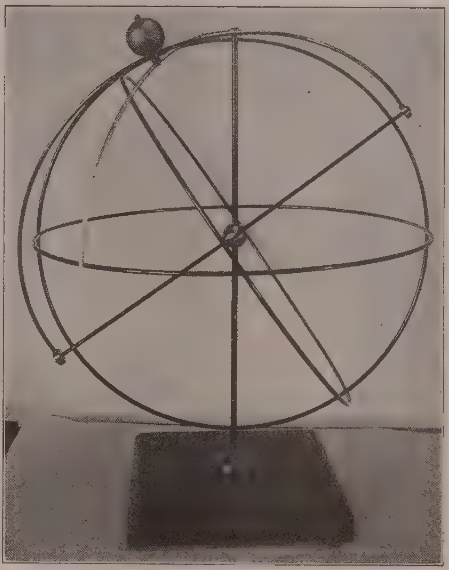
The other model is for a circumpolar star. The declination is fixed. The "star" may be moved in a full circle around the pole, illustrating changes in the shape of the astronomical triangle with changes of hour angle.

The circles representing the horizon, meridian, etc., are made of $\frac{1}{4}$-in. iron rods, and are 24 in. in diameter.

Trolley Tracks for Cleaners' Scaffolds on Buildings

Illinois Department of Factory Inspection Formulates Rules for Safe Construction of Swinging Scaffolds

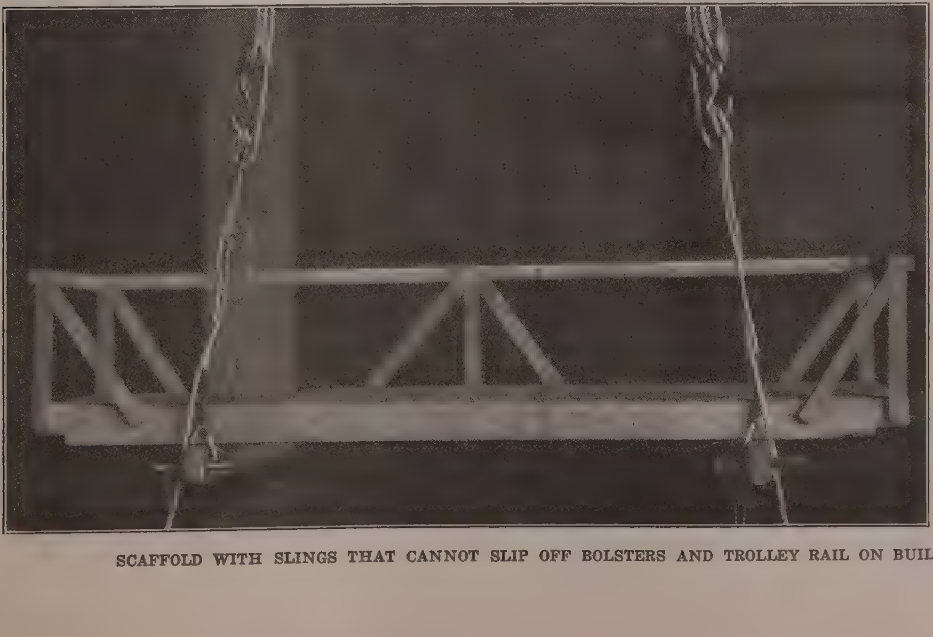
THAT an I-beam supported by brackets from the frame or walls of a factory building to furnish a support for painters' and cleaners' swinging scaffolds has the advantages of economy and safety has been pointed out by the Illinois Department of Factory Inspection, of which Oscar F. Nelson is chief. The I-beam furnishes a track for trolleys from which the scaffolds are hung. This arrangement, shown in the accompanying photograph, allows the scaffold, according to the department, to be moved rapidly in any direction, does away with thrust-outs and saves a great deal of time usually spent in rigging by the men engaged in maintaining the outside walls of buildings. Still more important, it is said to increase greatly the safety of these men, reducing correspondingly the liability risks.



UNIVERSITY OF CALIFORNIA MODEL ILLUSTRATES SOLAR OBSERVATION

The department has also recently issued an order prescribing the proper construction for light scaffolds used in building maintenance with a view to reducing accidents. A model painters' scaffold conforming to the requirements of the order is shown in one of the illustrations. Only $\frac{5}{8}$-in. wire rope with spliced loops may be used for slings on any scaffold, while $\frac{3}{4}$-in. forged steel stirrups must be used for tuck pointers' scaffolds. Where wire rope is used, a safety strap of rope must be spliced into both loops of the sling below the platform, and a $\frac{3}{4}$-in. bolt 6 in. long, held in place by pipe washers, must be put in each end of each bolster. The bolts prevent the loops of the sling from slipping off, and the safety strap, if the bolster should slip out of the sling, would catch the ends of the scaffold plank and prevent them from falling. The bolsters themselves must not be less than 2 x 4-in. straight-grained hickory or white oak. Bails must be secured to tuck pointers' scaffolds by steel clamps, and the wall braces used on such scaffolds must be secured with U-bolts, as bolts running through the floor pieces are not permitted.

These instructions were formulated at a conference between the Chicago building commissioner, the representatives of the Employing Painters' Association and of the unions concerned, and the chief state factory inspector.



SCAFFOLD WITH SLINGS THAT CANNOT SLIP OFF BOLSTERS AND TROLLEY RAIL ON BUILDING TO SUPPORT IT FOR CLEANERS' USE

Literature

For the Civil Engineer and Contractor

New Publications

The Use of the Slide Rule. By Allan R. Cullimore, dean, College of Industrial Science, Toledo University. Cloth, 6 x 9 in., 36 pages; illustrated. New York, Keuffel & Esser Company. 50 cents.

Loblolly or North Carolina Pine. By W. W. Ashe, forest inspector, U. S. Forest Service. Bulletin 24, North Carolina Geological and Economical Survey. Paper, 7 x 10 in.; 176 pages; illustrated.

The Caisson as a New Element in Concrete Dam Construction—Proposal made in connection with the Columbia River Power Project. By O. G. Aichel, civil engineer, Portland, Ore. Paper, 7¼ x 9¾ in.; 32 pages; illustrated. New York, Spon & Chamberlain, 123 Liberty Street.

Industrial Leadership. By H. L. Gantt. Cloth, 5 x 7½ in.; 128 pages. New Haven, Conn., Yale University Press. $1 net.

Standardization of Public Employments—Part 1. Paper, 6 x 9 in.; 117 pages. New York, Bureau of Municipal Research, 261 Broadway.

The American Road—Lessons for Correspondence Instruction. By James Irwin Tucker, professor of civil engineering, University of Oklahoma, and consulting state engineer, Oklahoma Department of Highways. Six booklets; paper, 4¾ x 7½ in.; total 228 pages, with numerous questions; illustrated. Norman, Okla., Extension Division, University of Oklahoma.

Sewage Purification and Disposal. By G. Bertram Kershaw, consulting engineer, engineer to the Royal Commission on Sewage Disposal. Cloth, 5½ x 8½ in.; 340 pages; illustrated. London, Cambridge Public Health Series, Cambridge University Press. 12 shillings net.

Relation Between Properties of Hardness and Toughness of Road-Building Rock. Office of Public Roads. Paper, 7 x 10¼ in.; 5 pages; illustrated. Washington, U. S. Department of Agriculture.

Effect of Controllable Variables Upon the Penetration Test for Asphalts and Asphalt Cements. Office of Public Roads. Paper, 7 x 10¼ in., 14 pages. U. S. Department of Agriculture.

Training for Municipal Service. Paper, 6 x 9 in.; 51 pages. New York, Bureau of Municipal Research, 261 Broadway.

Report on Hydraulic Data and Stream Gaging, 1914, Department of Barge Canal. Supplement to the Annual Report of the state engineer and surveyors, State of New York. By G. Edward Gibson, assistant engineer. Cloth, 6 x 9 in.; 367 pages. Albany, N. Y., Department of State Engineer, Barge Canal Office.

Some Engineering Problems of the Panama Canal in Their Relation to Geology and Topography. By Donald F. MacDonald. Bulletin 86, Bureau of Mines. Paper, 6 x 9 in.; 88 pages; illustrated. Washington, Government Printing Office.

Books Reviewed

Engineering as a Career

Edited by F. H. Newell, professor of civil engineering, University of Illinois, and C. E. Drayer, secretary, Cleveland Engineering Society. Cloth, 5 x 7½ in.; 214 pages. New York, D. Van Nostrand Company. $1 net.

This book, intended as a guide for teachers, parents and young men, meets a distinct need and yet falls curiously short of the mark. A collection of essays by twenty-two engineers and educators of national repute, it runs the scale from popularized pictures of some branches of the profession to accurate descriptions of the needs and requirements of others. It is interesting to note that several eminent men representing branches of the civil-engineering profession employ the worst English in the book, are most inclined to historical diffuseness and say the least of real meaning, while the men representing the newer branches of engineering, and one or two who have had experience as educators, have contributed essays that give a real guide to the qualifications and efforts necessary for success in the fields they describe. Is this because those in the newer divisions of engineering have had to develop their assistants from untrained material, and have found the problem of the natural fitness of others for their work a pressing every-day question? This is at least a suggestive conjecture. Certainly the primitive methods of selecting and promoting men in many large civil-engineering organizations would not be tolerated for a moment by the heads of the engineering forces employed by big chemical, mining or manufacturing companies.

As a whole, the book is well worth the effort to produce it, though a second effort might result in a much superior work. The chapters on Metallurgical Engineering, Electrical Engineering, Chemical Engineering, The Lure of Private Practice and Vocational Guidance are among the best, and are nearest the purpose of the book.

Reinforced Concrete Construction

Author, George A. Hool, S. B., associate professor of structural engineering, University of Wisconsin, assisted by Frank C. Thiessen, B. S., instructor in structural engineering, University of Wisconsin. Cloth, 6 x 9½ in.; 688 pages, 575 illustrations. New York, McGraw-Hill Book Company, Inc., $5.

REVIEWED BY F. H. CONSTANT

Professor of Civil Engineering, Princeton University, Princeton.

This is the third of the well-known series by the same author. The original intention of including many different types of reinforced-concrete structures has not been adhered to, and the present volume is devoted almost exclusively to bridges, especially arches. Culverts, in spite of their prominence in the title, are allotted only 35 of the total 688 pages. Structurally, the book has eight parts and thirty-seven chapters. Qualitatively, the first quarter covers the theory and design of arch bridges, and the rest of the book is wholly descriptive.

Part 1 (Arch Bridges) comprises about one-half of the work. Two general methods for the analysis of the elastic arch are given. The first is the analytical one which is in most common use in this country and leads to the simple equations for H_c, M_c and V_c at the crown for loading, temperature and rib shortening. It is illustrated by the design of an earth-filled arch for arbitrarily fixed live load, and of an open-spandrel arch in which unit loads and influence lines are employed. Considerable care is given to presenting all of the matter used in the computation of these bridges in a systematic and tabular form in the "designing sheets." The author has relied perhaps too much upon the tables to tell their own story; a clear explanation in the text of some of the more difficult points would be appreciated by the average reader.

An example of an unsymmetrical arch is worked out in a similar manner in Chapter 6. The three equations of condition for the crown stresses are given without derivation and the treatment is too brief for so complicated a subject. Chapter 7 contains a more satisfactory short treatment of arches with elastic piers. Chapter 8, of 50 pages, completes the mathematical part of the book by giving the second method of arch analysis, using the ellipse of elasticity. It is taken largely from the paper by A. C. Janni, read before the Western Society of Engineers, Jan. 13, 1913. The method is almost wholly graphical and is a modification of the one given by J. Milan in "Concrete Arches" (translated by D. B. Steinmann), in which the origin of co-ordinates is located at the center of gravity of the elastic weights, and the ellipse of elasticity is applied to the arch as a whole. Mr. Janni, however, extends the ellipse-of-elasticity principle to the individual arch subdivisions as well, a more exact but perhaps unnecessary refinement.

The presentation is not as clear as it might be, and leaves much to be read between the lines. This is to be regretted because unfamiliar graphical processes always appear more complicated than they really are, and the author states that this one is rapidly and easily applied and predicts that it is likely to be in great favor with American engineers as soon as it becomes better known.

Whatever criticisms may be made concerning the analytical part of the book, the descriptive part (beginning with Chapter 9) containing 400 or 500 beautifully executed illustrations covering both American and European bridges, could hardly be improved, and makes this the leading descriptive work on concrete (especially arch) bridges in this country. The remainder of Part I covers details and the construction of arch bridges, three hinged arches, a very interesting and timely chapter on arch patents in which the salient features of the leading patents are outlined, and a chapter of about 76 pages consisting wholly of illustrations of typical designs of the various types of arch bridges.

Part II (about 60 pages) covers slab and girder bridges; also abundantly illustrated from current practice. Part III treats of culverts, touching upon culvert efficiency, pressures on pipes in ditches and the strength of pipes, summarized from the investigations made at the Iowa State College of Agricultural and Mechanical Arts, and at the Engineering Experiment Station at the University of Illinois. Box and arch culverts, with a theoretical treatment of the former, are also included.

Part IV, written by A. W. Ransome, is entitled "Notes on Construction Plant," and is a practical discussion of the methods of handling materials, and mixing and distributing concrete. Part V, written by Leslie H. Allen, gives several examples of typical estimates for bridges with cost data. Part VI, written by William J. Titus, on "The Artistic Design of Concrete Bridges," is one of the most interesting and valuable in the book. It analyzes in detail the esthetic elements of a concrete bridge and illustrates them by many photographs of American bridges, showing both good and bad design.

Part VII on "Construction in Detail," is written by Albert M. Wolf, and covers field details and methods adapted for several important structures, notably the Yardley Bridge, the Tunkhannock and Fort Worth viaducts, and various pile trestles and track elevation subways. The work closes with Part VIII (75 pages) written by Philip Aylett and P. J. Markmann, on European concrete bridges, containing an interesting discussion of art abroad and a comparison of American and European practice, especially in regard to the beauty, lightness and economy of the foreign structures. American engineers can undoubtedly profit by the more perfect art in Europe.

The chapter on hinged arch concrete bridges, with its illustrative details, is most valuable and emphasizes this important type of structure, although American engineers may not be ready to agree at once with the author in regard to the superiority of the three-hinged arch.

The book is essentially a work of reference. As such it will fill an important place in the field of concrete construction.

Materials of Construction

Author, G. B. Upton, assistant professor of experimental engineering, Sibley College, Cornell University. Cloth, 6 x 9 in.; 319 pages, 181 illustrations. New York, John Wiley & Sons, Inc. $2.50 net.

REVIEWED BY MELVIN L. ENGER

Assistant Professor of Mechanics and Hydraulics, University of Illinois.

This book was written for students taking the laboratory course in materials of construction at Sibley College. The title of the book is misleading, since most of it is given over to cast-iron and steel. There are two sketchy chapters on non-ferrous metals and alloys, and cement and cement testing. Timber is treated casually and wrought-iron is not mentioned. There are no collections of data concerning the properties of materials.

Part 1 is entitled "The Determination of the Properties of Materials." It includes a discussion of the internal structure of materials and action under load (tension, torsion, compression and combined loadings), impact tests, hardness tests, fatigue, corrosion, working stresses and factors of safety. Derivations are given of the torsion, flexure, horizontal shear, and combined-loading formulas. Better derivations may be found in many text books on the mechanics of materials.

There is included a new and very ingenious analysis for finding the actual shearing stress in the outer fibers of a shaft when they have been stressed beyond the yield point. A similar analysis is given for the actual stress in the outer fibers of a beam when they have been stressed beyond the yield point. Concerning these analyses the author makes the following optimistic statement: "The new method for torsion and transverse test analysis may clear up controversies concerning 'Guest's Law' or other laws for conditions of failure in combined loadings, and may make tests of ductile materials in direct shear unnecessary." No derivation is given of column formulas, but the Euler, J. B. Johnson, Ritter-Merriman and Rankine-Gordon formulas are discussed. The author concludes that the J. B. Johnson and the Euler formulas should be used. The straight-line formulas for columns are not mentioned, nor is it explained how stresses due to eccentric loadings may be calculated.

Part 2 is entitled "The Nature of Materials and Control of Their Properties." It includes a discussion of the nature and origin of the structure of alloys; the shaping of steel and the control of final properties during the shaping process; the effect of carbon on the properties of carbon steels, and effects of elements other than carbon; general theory of heat treatment and heat treatments of carbon steels; cast-irons; alloy steels; non-ferrous metals and alloys, and cement and cement testing.

The book is written in a dogmatic style, and many of the statements are open to criticism. For example, it is stated that "one of the reasons for the high factors of safety used in the design of masonry and concrete is that the factor of safety has to cover the error in strength due to using a cubic test piece." In another place it is stated that "live loads applied without shock (for example a rolling load crossing a bridge at a low speed) actually set up stresses twice as great as a dead load of the same weight." There are many who will question the statement that "the experimental work of Guest, Scoble, Hancock and others has now made it practically certain that the magnitude of the stress is the controlling factor, not the magnitude of the deformation."

Except in the last two chapters references are usually not given. Instead of referring the reader to the various yearbooks of the American Society for Testing Materials he is told that "Any one desiring to know what may be proper standards and specifications for any material, so far as standards have been adopted, may communicate with this society."

Having pointed out some of the faults of the book, it must be said that it contains much valuable matter treated in a stimulating manner. Throughout the book boldface type is used to emphasize important statements and conclusions. It is a book which will be read with profit by all interested in the subject.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Why Is Registration in Civil Engineering Decreasing?

Sir: Without taking space for discussion or modification I wish to say that I am heartily in accord with the sentiments expressed by Professor Swain in his letter published in the Engineering Record of Feb. 26, 1916.

MALVERD A. HOWE.

Terre Haute, Ind.
Director of Departments of Architecture and Civil Engineering, Rose Polytechnic Institute.

Topographic Survey of Rough Wooded Area

Sir: In the Engineering Record of March 4, under the caption of "Unusual Methods Simplify Topographic Survey of Rough Wooded Area" the authors of that paper describe what they call the *usual* method of making plane table topographic surveys briefly as follows:

"(2) the plane-table method, in which horizontal control is provided by a large number of plane-table stations established by transit and tape traverses, the contours being directly located either by using the plane-table alidade as a level or (more commonly if the ground is uneven) by using engineers' level in conjunction with the plane-table."

Far from being the *usual* method of making topographic surveys with a plane table, the method thus briefly described is a most *unusual* one, which, because of its lack of flexibility, produces accurate maps only at unusually high unit costs. A very conspicuous example of this is the topographic survey of the District of Columbia made some decades ago by one of the federal surveyors. In making this survey the contours were located on the ground with a wye level and were then mapped with the plane table. The cost of this survey was said to be somewhere near $5 per acre.

Because the economic and in all ways most advantageous use of the plane table requires considerable skill, which can be obtained only by steady experience of some length, few engineers outside of the government bureaus are adept in the most usual methods of making a topographic survey with this instrument. Briefly they may be described as follows:

The horizontal control may consist of traverse stations determined by the usual methods or of triangulation stations; the vertical control consisting of suitably placed bench marks. The horizontal position of the plane table is obtained in any of a number of ways, as by setting directly over a known station, by a graphic solution of the three-point problem, by use of stadia in carrying a plane-table traverse from a known station, by resection, etc. It is possible that the foregoing statement in no wise differs from what the authors intended to convey when writing the statement quoted above.

The point which I am anxious to make comes in when considering the latter part of the quoted statement. In the ordinary use of the plane table a height of instrument is obtained from a known station either by direct leveling, using the alidade as an ordinary level, or by reading the angle on the vertical arc of the alidade and making computations therefrom. It is this use of the vertical arc which has apparently been overlooked by the authors of the article above referred to and which makes the plane table the most flexible of mapping instruments, rendering possible with it surveys of most difficult regions at an economy of time and money and of any desired accuracy (even the highest).

In this manipulation of the plane table no effort is made to get the rod on the even contour, but rod readings are taken at all salient points of the topography and the contours interpolated therefrom. In this way every break in the ground, every change of grade, each small change in the conformation of the ground is plotted. Rod stations are made where they will best serve to obtain and portray the true configuration of the ground. In broken ground, along banks of ravines, where ravines "head up," and in hundreds of other places where the topography is intricate in detail, these rod stations will come close together, while on the more uniform topographic figures the number of rod stations per unit of area will be considerably diminished. Using this method the topographer can work his way through the most difficult country and secure a map of any desired accuracy at an economy over any other known method.

To make good this last statement the topographer must be an experienced plane-table man, and it is the opinion of those who have had to do with the training of such men that at least two years of steady experience is required before the plane-table topographer can render expert service. For this reason many engineers who are really unfamiliar with the best use of the plane table, judge it by limited performances of inexperienced men and give it a "black eye." Acquaintance with plane-table methods and results as practised and obtained by experts will always convert an engineer into an ardent advocate thereof.

As a splendid example of plane-table work of high accuracy and great economy I might cite the Topographic Survey of 1912 of the City of Cincinnati, where something like 100 sq. miles of topography were mapped on the same scale and contour interval as the survey of the District of Columbia above referred to but at a cost of less than $1 per acre. The relief of the territory mapped is somewhere near 500 ft., much of it very steep, necessitating that the vertical circles be used the greater part of the time.

In all the federal bureaus which have extensive topographic surveys to make (mostly of wild areas), the plane table is the universal mapping instrument. It deserves greater recognition by private engineers who have only occasional need for topographic surveys, and it is wholly with the idea of overcoming any adverse effect on the deserved progress which the plane table is making toward being utilized in private topographic surveys that the statement quoted at the beginning of this letter is challenged.

HUGH C. MITCHELL.
Geodetic Engineer.

Washington, D. C.

[Copy of this letter was submitted to Messrs. Davis and Rayner, authors of the article in question. Their reply, signed by Mr. Davis follows.—EDITOR.]

Sir: I am in receipt of your letter of March 10, with the copy of a letter from Hugh C. Mitchell, challenging a statement in the article by Mr. Rayner and myself in the issue of March 4.

A careful study of Mr. Mitchell's letter seems to indicate either that he did not read the article understandingly, that he is confusing large-scale work with intermediate-scale work, or that he has not put much thought on dependence of methods on the scale, contour interval, and topographic conditions.

Having recited the conditions (scale: 50 ft. = 1 in. and contour interval, 2 ft.) the article states, "Perhaps the two most common methods on *large-scale* surveys are:"

It is generally conceded among topographic engineers that, for the scale and contour interval stated, unless the topography is very regular, the contours must be directly located if the accuracy of the map is to be consistent with the scale. Of course, it is at once apparent that the vertical angle and stadia method, which Mr. Mitchell goes to such length to describe, and with which we had supposed nearly every surveyor was familiar, can not be used to locate contours directly.

A varied experience in topographic work from the small scales and large contour intervals used by the Geological Survey to the scale of 1 in. = 40 ft. and 1-ft. contour interval used by the landscape architect, from mountainous and forested country to the prairies of the Middle West, leads us to believe that there are about as many "best methods" as there are combinations of conditions, or in other words that the problem of providing most efficient methods and best form of organization is one in which the scale and contour interval as well as the character of the topography and the state of cultivation require careful consideration. The point that Mr. Mitchell fails to grasp and the point which makes his letter misleading is that, while the method that he describes is the most common plane-table method for the intermediate scale and contour interval, say 400 ft. = 1 in. and 5-ft. interval, it is not a general plane-table method that is to be used with every scale and every contour interval and certainly could not have been rightly used with conditions of topography, scale, and contour interval stated in the article.

That the method briefly outlined in the article as one of the two common methods is, as Mr. Mitchell states, "a most unusual one" is, we hope, true for *intermediate-* or *small-scale* surveys. The District of Columbia survey is a good example of the expense of needless refinements; but that the method is not unusual for large-scale surveys will, I venture to say, be pretty clearly established if one consults the present-day literature on topographic surveying.

THESE WILLOW ROOTS BURST 6-INCH TILE DRAIN SEWER PIPE

Aside from its failure to take cognizance of the effects of varying conditions, I should like to echo the general sentiments of the letter; though I am inclined to think, from the number of state and municipal surveys on which the plane table has been the chief mapping instrument in the past few years, that there are a considerable number of expert plane-table operators who are not connected with the federal surveys and that the profession in general is not as ignorant of the possibilities of the instrument on intermediate- and small-scale work as the letter would lead one to believe. A fact that is not so generally realized, except perhaps by landscape architects, is that the plane table is equally well adapted to large-scale work, provided horizontal and vertical control is properly established and proper methods of procedure are employed. Although in general it may be said, regardless of the scale, that with experienced topographers the plane table is the most efficient of mapping instruments, the statement of the letter that "the topographer can work his way through the most difficult country and secure a map of any desired accuracy at an economy over any other known method," is to say the least a bold statement and one which I think would not prove to be true of intermediate- or large-scale surveys in heavily wooded country, of surveys made during the extreme cold of winter, or of line surveys which require the topography of only a very narrow strip. And by way of further emphasizing the impracticability of the plane table under these conditions there comes to mind a winter on railroad preliminary in the dense forests of Canada with 6 ft. of snow on the level, the temperature occasionally dropping to 60 deg. below zero, and the trees dropping their burdens of snow at the slightest disturbance.

R. E. DAVIS.

Urbana, Ill.

Willow Roots Crack Six-Inch Tile Sewer Pipe

SIR: The accompanying picture shows the roots of a willow tree taken from one section of a 6-in. drain tile. When first taken out of the tile it was exactly cylindrical. The specimen from which this piece was cut was 285 ft. long, ranging in diameter from large enough to burst open a 6-in. tile down to a single root the size of a thread, which is the same root as the largest one projecting from the specimen shown in the picture.

The roots had broken the tile open at the inlet of the tile and had diminished in size and number toward the outlet, which would indicate that they would not enter a tile at its outlet but will do so readily and quickly at its inlet. In this particular case the willow trees were on the opposite side of the road from the tile, but near the inlet. We have other cases where willow trees are near the outlet, but have witnessed no difficulties as shown in this case.

This tile was laid about three years ago and is an example of what may happen to an ordinary drain tile when placed in the neighborhood of willow trees.

A. R. HEBENSTREIT,
Tama County Engineer.

Toledo, Ohio.

Qualifications for Engineering Work

SIR: The writer has been asked on different occasions to give the Carnegie Foundation his views upon the qualifications for engineering work.

He notes with interest the editorial in your issue of March 11, based upon the last circular and card sent out by the foundation. The intimation is that the six qualifications with broad subordinate factors shall each be valued at some figure as shall make a gross percentage of 100.

Your article very properly calls attention to the fact that different qualifications, or a different order of qualification may be required for different classes of work.

The writer wishes to emphasize one feature that has apparently not been brought out, that the item "character" could not be subdivided as a factor to be combined with judgment, efficiency, knowledge, etc., in a gross percentage, but should stand at 100 per cent itself.

It has been the writer's experience in dealing with a large number of engineers that their "character" has as a rule ranked high. Responsibility, resourcefulness, and initiative are valuable elements in the make-up of an engineer, but integrity and so-called "character" must be required at as nearly 100 per cent as possible if success is to be achieved.

LOUIS L. TRIBUS.

New York.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Heater Melts Snow to Finish Asphalt Paving Job

BY J. T. CHILD
Winnetka, Ill.

THE ROLLER heater shown in the accompanying photographs saved the day last December when an early snowstorm caught a Chicago paving contractor with 5400 sq. yd. of asphalt penetration pavement to finish on a $180,000 contract at Glencoe, Ill. The heater melted the snow and warmed the road surface with a hot blast at high temperature, and made possible the satisfactory completion of the asphalt work at a comparatively low cost.

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SPECIAL HEATER MELTING SNOW AND WARMING ROAD SURFACE TO ALLOW COMPLETION OF ASPHALT PAVEMENT UNDER WINTER CONDITIONS

The 2 in. of crushed stone for the wearing surface was already in place on the concrete base when the snow came. It was decided to make an effort to remove the snow, heat the stone and finish the pouring before winter set in. For this purpose gasoline, hand-propelled road heaters were thought of, but proved to be too costly and slow for this particular work. However, the contractor set a crew to work which removed the heavy part of the snow with brooms and shovels at a cost of $17.

Then a Barbour heater, with a patching hood, was hired at $20 a day. The engineer received $6.50 and his helper $3.50 a day, including carfare. Pocahontas coal at $6.25 per ton, delivered, was used and about half a ton a day was necessary for this work. The heater consisted of an 8-ton tandem roller, rigged up with a special flue leading from the boiler over the top and down to a 5 x 7-ft. hood which could be lowered till flush with the pavement. The flue gases were blown through, by a forced draft, to the hood, where they were disseminated over the roadway at a high temperature. This melted the snow and frost and heated the stone, and the asphalt was then poured immediately before the stone became cold. Heated chips were used to fill the voids in the first course and also on the top dressing.

It took four days to melt the snow and complete the work on this 5400 sq. yd. The extra cost for the snow removal alone was $150 or approximately 3 cents a square yard. The finished pavement was more costly also because of the time lost in working so close behind the heater and the expense of heating the chips used. The actual pouring was done at about half speed, 1500 sq. yd. a day being done as against 3000 sq. yd. in warmer weather.

After the snow was melted, the heater followed up the recently finished pavement and sweated up any spots which were not in good condition. These places were repoured and rerolled, thus making a better job than would have been otherwise possible. In spite of the extra effort and expense, the heater more than proved its value for this emergency work as it saved the much greater expense of leaving the pavement unfinished and coming back to complete it in the spring. At present, three months after the work was done, the pavement is in excellent condition and shows no sign of raveling, nor is there any indication that it was done under different weather conditions from the main part of the job. John A. McGarry & Co., the firm which used this method, carried out the contract for the entire 63,000 sq. yd. of paving.

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MELTING ROUGH SPOTS IN PAVEMENT LAID AFTER SNOW, WHICH IS SAID TO BE EQUAL TO THAT BUILT IN OPEN WEATHER

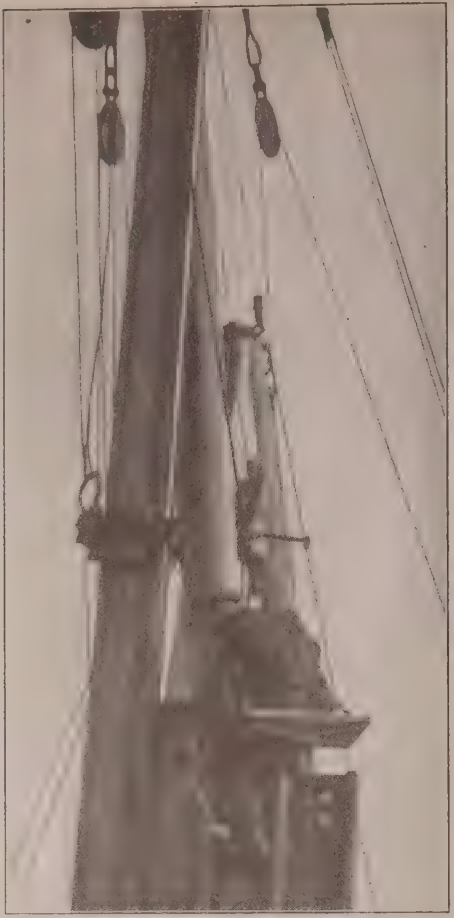
Barge Replaces Trestle in Making Rock Fills at Halifax

BY USING a dumping bridge supported between the end of the fill and a large scow by an A-frame boom, the difficulties of building a trestle on rock bottom and maintaining it while making a rock fill have been avoided in constructing the Halifax ocean terminals in Nova Scotia. The stringers of the bridge are of timber, and are suspended from the A-frame at the center of the bridge on the same principle as is used in swinging the gang plank of the familiar river steamer. Two 18-yd. side dump cars at a time can be dumped from the bridge into clear water between the barge and the end of the fill. In order to save switching, the track extends the full length of the barge to accommodate four cars that have been dumped while the fifth and sixth are dumping. Thus the only loss over operation on a trestle is that the whole train cannot be dumped simultaneously. This is more than made up by saving the time and expense of building and maintaining a trestle on rock bottom in 30 to 60 ft. of water.

The fill for the breakwater has been finished, that for the center of pier B is now being completed, and that for the center of pier A will be made in this way. All three are long, narrow fills built out from the end. Material from a heavy cut on the railroad approaching the terminal, for which the Cook Construction Company and Wheaton Brothers are contractors, is being used.

Clamp Handles Long Steel Sheet Piles in Safety

THE clamp shown in use in the accompanying photograph has replaced chains in handling steel sheet piles being driven in the open trench at the Staten Island end of the Narrows siphon in New York City by the Merritt & Chapman Derrick & Wrecking Co. Where the derrick boom is not sufficiently long to raise sheet piles by the upper end high enough to thread them, it is a common sight to see chains and wood blocks used to hitch to the pile a little above the center. In handling long, heavy piles on such a hitch, there is danger of the hitch loosening before the pile is fairly threaded to the one in which it is being entered, which would result in dropping the pile. The clamp shown removes this danger, as its grip on the pile is independent of the tension on the derrick line. It consists essentially of two wooden halves, reinforced with steel straps, which are cut out to fit around the pile, and held together at each end by a through bolt. To save carrying up wrenches each time to loosen the clamp, the heads of the bolts are countersunk and chocked in one of the wooden halves, and the threaded ends project through holes in the other half of the clamp.



CLAMP HOLDS PILE SECTIONS

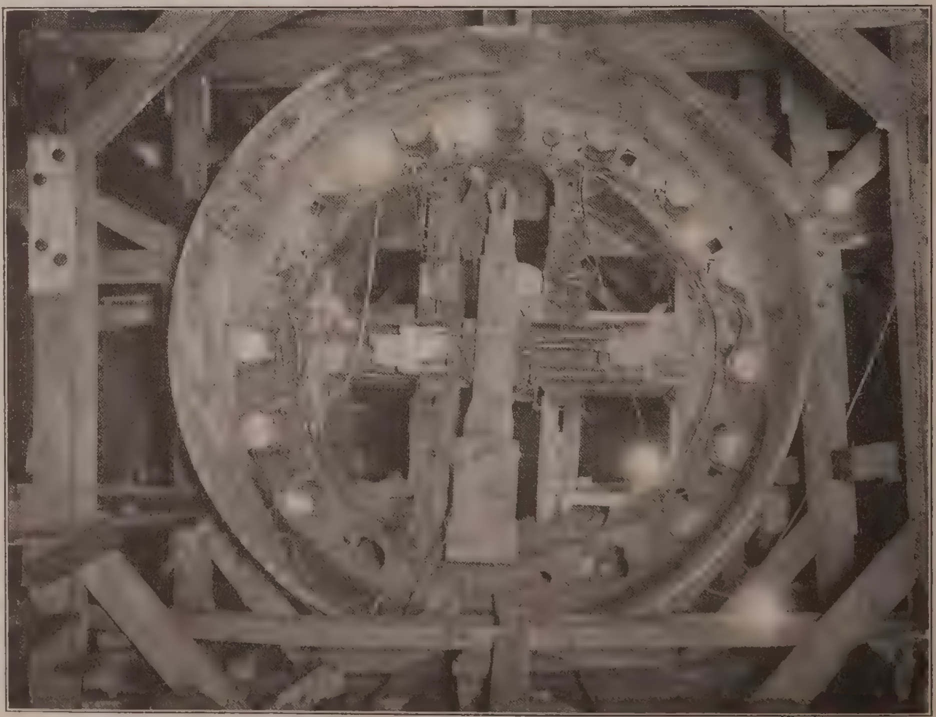
The nuts for these bolts have an 8-in. wrench handle welded to them. It is necessary to take both of the nuts off to loosen the clamp, but its halves are shackled at one end to the pile line, so that there is no danger of dropping them into the water when the clamp is taken off. Captain Tooker is in charge of the construction of the trench for the contractors under Ralph E. Chapman.

Shield Moves Itself to Place to Start New Tunnel

TWO TUNNEL shields weighing 75 tons apiece recently moved themselves by two of their own jacks more than 300 feet across the open bottom of a shaft in Willoughby Street, Brooklyn, N. Y. The section of the New York Municipal Lines connecting the Fourth Avenue subway with the Clark Street tubes is being driven by the shield method on account of its depth below the street. Two shields were set up and driven west from the Manhattan bridge plaza, the north one being timed to reach the large shaft at Lawerance Street first. In constructing this shaft, two lines of posts and the crossbracing were omitted for a height of 20 ft. to clear the shields. The timbering above this gallery was knee-braced and trussed. The opening was left on the line of the south tube, and was used to pass both shields. The first shield was jacked over sidewise onto a road of 12 x 12-in. timbers laid crosswise in this passage. It was carried in a timber cradle on greased skids. The two bottom jacks were used to shove it along. As the push required was far less than in shoving the shield in solid ground, kickers braced into the ground behind were used for the jacks to push against. Blocks were inserted after each move, and the kickers moved ahead only at intervals. At the far end of its ride in the open each shield was lined up in advance of an 8-ft. thick concrete block set below the shaft floor. Between these and each shield the lower plates of the first lining ring, and an increasing number of plates of each succeeding ring were set until a full circle was completed in the last ring within the tail of the shield. In this way the shield was able to use all its jacks in taking the first shove into the new heading.

It is thought that this is the first time a large tunnel shield has ever been moved from one tunnel heading to another without taking it down and re-erecting it. To move the first shield 30 ft. sideways and 325 ft. lengthways took only two days with a much smaller crew than could have dismantled and re-erected the shield in a minimum time of three weeks.

These tunnels are being driven for the Public Service Commission, Alfred Craven, chief engineer, Robert Ridgway, engineer of subway construction, and George S. Rice, engineer of the division including the work, by the Flinn-O'Rourke Company, Inc., of which George H. Flinn is president and Major John F. O'Rourke vice-president and chief engineer. Michael L. Quinn is general superintendent for the contractor.



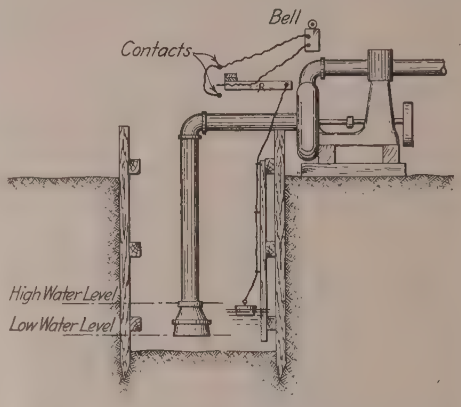
HEAVY SHIELD JACKED IN TWO DAYS 325 FEET TO POSITION FOR STARTING NEW BORE

Water Level in Sump Regulated by Electric Bell

By H. S. CARPENTER
Cobleskill, N. Y.

AN ELECTRIC alarm bell, the working of which is shown in the accompanying sketch, was used successfully by the writer to hold the water level constant at night in the sump of a centrifugal pump used to unwater the foundation in building a pumping station.

To the lighter end of an unbalanced lever hinged near the middle was attached a line at the lower end of which was a float resting on the surface of the water in the sump. The weighted end of the lever closed the electric bell circuit when the contact on its end touched either the upper or the lower contact points shown on the diagram. As the water fell the weight of the float raised the lever contact till it rang the bell by the upper contact. As soon as this happened the pump runner would close the throttle valve somewhat and slow down the pump. The water level in the sump would then rise, carrying the float with it, and the weighted end of the lever would sink till it touched the lower contact and again rang the bell. At this signal the pump runner would give the engine a little more steam and begin to lower the water again. In this way a centrifugal pump with an 8-in. discharge was able to handle a flow of 1800 gal. per min. and keep the water level constant at night without having to shut down the pump to prime it and thus interfere with work in the hole.



BELL SIGNALS WATER LEVEL IN SUMP

Before installing the bell there was trouble both day and night with the pump, but after the bell was put in use there was no further difficulty in keeping the water down.

Testing Tractors for Army Guns

The United States Army is conducting a series of tests at Fort Sill, Okla., to determine the efficiency of motor trucks and tractors in hauling 4.6-in. guns and 6-in. howitzer batteries as compared with the animal equipment now used.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Paris, Tex., Almost Completely Destroyed by Fire

Entire Business Section and Half of Residence Ruined—Reinforced-Concrete Buildings Stand Terrific Tests

A fire on Tuesday, March 21, almost entirely destroyed the city of Paris, Tex., the population of which is about 18,000 persons. The burned area, estimated by the state fire marshal to be 264 acres, covered nearly 150 city blocks and composed the business section and almost half of the residential portion of the city. According to O. H. Lang, of the firm of Lang & Mitchell, architects and structural engineers, of Dallas, Tex., who sent the information to the Engineering Record, the fire brought to light some interesting subjects in connection with insurance building requirements and fire fighting methods when concrete buildings are being protected from the blaze.

1440 Buildings Destroyed

A high wind whipped the blaze into an immense conflagration, and, when the six-story Gibraltar Hotel caught fire, the flames are said to have leaped several hundred feet into the air, and by the time the fire had been put under control 1440 buildings had been destroyed, among which were 704 residences, 117 brick buildings, 113 churches, 9 public buildings and a number of less important structures.

Three reinforced-concrete buildings were the only ones to come through practically unharmed, the concrete frame of the Gibraltar Hotel was damaged only slightly and the closed elevator and stair shafts with the overhead machinery were found to be in perfect working order.

The gypsum-block partitions and wire-glass and metal windows, and reinforced-concrete work were practically unharmed by the flames while partitions, windows and buildings of materials other than these were practically destroyed. One concrete building was put to an additional test when dynamite was used to destroy surrounding buildings.

Despite the intense heat to which it had been subjected, the refrigerator system in the Gibraltar Hotel was in such good condition that ice water was available as soon as the hotel could be entered and the temperature in the ice boxes was only slightly above normal.

Fight to Prevent Pollution of New York City's Water Supply

Bills providing for the removal of the Mohansic State Hospital for the Insane and the New York State Training School for Boys at Yorktown Heights from the Croton watershed were defeated in the Senate and Assembly March 22, by votes of 23 to 24 and 65 to 71. Much public interest has been aroused in this attempt to defeat the present plans for turning the effluent from the sewage treatment plant into Mohansic Lake which is connected with Croton Lake. Governor Whitman is said to have threatened to call an extra session of the Legislature to force the abandonment of the institutions which threaten New York City's water supply.

The Real Estate Association of the State of New York has appointed a pollution committee to co-operate with the Merchants' Association in effecting the removal of the two institutions from the Croton watershed.

Editorial mention was given this subject on page 372 of the Engineering Record for Sept. 25, 1915, and a similar situation was discussed on page 594 of the Nov. 30, 1912, number.

American Railway Engineering Association Holds Meeting in Chicago

Clearance Diagram Furnishes Main Subject for Debate at Seventeenth Annual Convention—15-Foot Clearance Adopted

The clearance diagram, 16 ft. wide, proposed by the committee on rules and organization at the seventeenth annual convention of the American Railway Engineering Association in Chicago, last week, precipitated the main debate of the convention, a discussion which occupied an entire three-hour afternoon session. The diagram ultimately adopted is a compromise between the 16 ft. proposed by the committee and the 14 ft. adopted by the society several years ago. The new diagram is presented on page 446. Perhaps the next most interesting discussion was at the Tuesday evening session, when Robert W. Hunt and C. W. Gennet, Jr., presented their paper on "The Nick and Break Test for Steel Rails." In general the discussion was light, comparatively few recommendations being put forth by the committees for adoption by the association, and several of those recommendations being referred back to the committees for further consideration. The attendance, the financial status of the society, the president's address and the officers elected for the coming year were briefly reported in last week's issue.

Discussion of Committee Reports

Ballast.—Objection was raised to the classification of ballast offered, in which broken slag (not granulated) was placed second to stone, and ahead of gravel. G. J. Ray of the Delaware, Lackawanna & Western stated that his company was using washed gravel under main tracks where he would not consider the substitution of slag. His motion that the matter be referred back to the committee was seconded by Charles S. Churchill of the Norfolk & Western, who held that the difficulty with the committee's report lay in the lack of descriptive matter pertaining to the different kinds of ballast. He held that certain slag was superior to gravel, but that other slag was inferior. The motion prevailed.

There was some discussion of ballasting by contract. R. H. Ford of the Rock Island, who was familiar with the ballasting by contract done by the Missouri Pacific some years ago, and referred to in the committee's report, stated that the results had been entirely satisfactory, there being no trouble from delayed trains, and the work being done better and more cheaply than by company forces. He conceded freely that the contract method was desirable only under certain conditions.

Ties.—W. H. Courtenay of the Louisville & Nashville, commenting on the new specifications for crossties in which longleaf strict heart yellow pine was excepted from the wood to be treated, stated that in his experience such pine, although creosote would admittedly penetrate it only about ¼ in., would nevertheless last at least three times as long when so treated. J. L. Campbell of the El Paso & Southwestern, also emphasized the value of even shallow penetration. The revised specifications for crossties and the proposed specifications for switch ties were adopted substantially as offered.

Track.—In presenting for adoption the typical layouts of Nos. 8, 11 and 16 double crossovers and double slip crossings, J. B. Jenkins of the Baltimore & Ohio, chairman of the committee on track, pointed out the lack of symmetry of these layouts, and asserted that this was necessary for the proper protection of the frogs. He also asked for the inclusion in the plans of several explanatory notes, and these were adopted with the plans.

There was some discussion of the guard rail offered, objection being raised by C. E. Lindsay of the New York Central to the use of filler

Repointing the Face of the Woolworth Building

Hundreds of feet above the ordinary skyscrapers in New York men are at work repointing many of the terra-cotta blocks with which the Woolworth building is faced. The whole surface will be gone over, the joints being cut out with a channeler and a considerable tonnage of new blocks reset to replace those broken and chipped due to the expansion and contraction, and also to freezing of the moisture which has seeped into the joints. As the original mortar was not of an elastic nature it has worked out in places under the vibration. So as not to bruise or break away the enameled surface, the blow of the electric channeler used can be regulated, when the hardness of the mortar varies, by means of a variable resistance placed in the feed wires, which are attached to the ordinary electric-light socket. The cracks vary from ¼ to 1 in. in width, and must be cut back ¾ to 1 in. The photograph shows men at work channeling out the mortar on one of the small towers. The scaffold is carefully screened to prevent pieces of mortar falling to the street. Five operators equipped with Electro-Magnetic Tool Company electric hammers are doing the work for the Atlantic Terra Cotta Company.

CUTTING OUT JOINTS FOR REPOINTING ON TOWER OF WOOLWORTH BUILDING blocks bolted to the main rail rather than rail braces to hold the ends of the guard rail. H. T. Porter of the Bessemer & Lake Erie, member of the committee, pointed out that these blocks had not been found to weaken the main rail as Mr. Lindsay thought, and that they were important as footguards. Mr. Campbell urged the provision for an adjustable filler block at the center of the guard rail to allow the wear to be taken up, and this suggestion was incorporated in the vote to adopt the recommended rail. The definition and specification for frog guard rails were adopted, as were the changes in the specifications for ordinary screw spikes. The proposed screw spike was withdrawn when Hunter McDonald of the Nashville, Chattanooga & St. Louis pointed out that the small square head would not stand brine drippings. The designs for cut spikes and for double switch lugs were withdrawn by the committee.

Iron and Steel Structures.—Little discussion preceded the adoption of the specifications proposed for the protection of traffic at movable bridges. In connection with the subject of turntable design, one of the assignments of the committee, A. F. Robinson of the Santa Fé gave a very favorable account of the performance of three 100-ft. turntables installed on his line. He pointed out, however, that they were not foolproof, and must be designed and handled carefully.

Masonry.—Mr. Churchill objected to the conclusion regarding the appearance, wearing qualities and cost of various methods of surface finish of concrete that coating with a wash of cement was not to be recommended. He held that it had worked very satisfactorily with brick, and he thought it was equally applicable to concrete. The consensus of opinion seemed to be against him, however. The association approved the general findings of the committee on this subject, but it was pointed out that the specifications contained much matter that should be presented elsewhere as information, and the whole subject was referred back to the committee for rearrangement.

There was considerable debate on the advisability of using, in reinforced-concrete construction, steel reinforcing bars rolled from old steel rails. T. L. Condron of the committee asserted that he was unable to see any objection to this method, as he held that there was no structural change in the old rail. The general opinion, however, seemed to be that proof is lacking, that there is no structural change, and that the railroads cannot afford to take the chance. At the suggestion of Mr. Campbell that the association was not qualified to answer the committee's questions on the subject, it was decided that the committee would have to answer the questions for itself.

Signs, Fences and Crossings.—There was considerable debate over the designs submitted for track construction at street crossings and in paved streets. E. A. Frink of the Seaboard Air Line summed up the sense of the convention that the committee had not gone deeply enough into the subject and that more designs, to meet all conditions, should be submitted. The subject was, therefore, referred back to the committee.

Rules and Organization.—G. D. Brooke of the Baltimore & Ohio, chairman of the committee on rules and organization, stated that the committee had been definitely asked by the American Railway Association to recommend clearances to specific structures as it had done, and had been urged to hurry its report as much as possible. The specific clearances it proposed were shown graphically by lantern slides.

In the lengthy discussion that followed there were those who thought the association should not recommend any clearance diagram; others who thought the matter should should be referred back to the committee for further study; still others who thought the association should decide the matter and decide it at that meeting, in view of the activities of legislative bodies. Of the latter class there were various advocates of 14, 15 and 16 ft. G. W. Kittredge of the New York Central applied himself to the protection of the special clearance diagram for third rail worked out by the committee on electricity.

Mr. Courtenay, contending that the clearances proposed were excessive and would lead to legislation that would affect present construction, moved that the attempt to establish a clearance diagram be abandoned. This motion was overwhelmingly defeated. Mr. Ford then moved that the matter be referred back to the committee, with instructions that it confer with the committee on electricity and with others concerned. Mr. Kittredge pointed out that time was valuable, mentioning that a congressional bill now pending stipulates a free space of not less than 36 in. horizontally between equipment and permanent structures. Mr. Brooke pointed out that some states have already adopted clearance diagrams. A. J. Himes of the New York, Chicago & St. Louis, member of the committee, urged that the association pass upon the question at once, pointing out that legislation was pending and that the association should lead the way, and not follow. Mr. Churchill added that the association should act on the matter because the American Railway Association had requested it to. The Ford motion was then put to a vote and lost.

Prefatory to the determination of the side clearance, which was admitted to be the crux of the matter, Mr. Kittredge argued strenuously for the rejection of any diagram that would clash with the diagram worked out by the committee on electricity and adopted by the association to provide for third rail along electrified lines. While some held that the diagram for which Mr. Kittredge was contending was a special diagram not applicable in many cases, and that the simpler form proposed by the committee on rules and organization should be used for general purposes, Mr. Kittredge's motion prevailed, that for the first 2 ft. above top of rail the electricity committee's diagram be substituted for that proposed by the committee on rules and organization, and that the two diagrams be connected by the necessary horizontal lines at the elevation of 2 ft.

W. C. Cushing of the Pennsylvania Lines West then moved that a side clearance of 7 ft. from center of track be adopted. A. S. Baldwin opposed this motion. He stated that the association had two alternatives, the one being to adopt a narrow clearance and try to hold legislation to it, with the danger that public sentiment would condemn such clearance as unsafe and go to the opposite extreme; the other being to adopt a more liberal view which would be more likely to hold future legislation. Mr. Cushing conceded that he, too, desired to point out the safe way to the public, but insisted that there was no proof that 7 ft. was not safe. His motion, however, was voted down.

Mr. Lindsay then moved that a side clearance of 7½ ft. or a total width of 15 ft. on tangent be adopted from a point 4 ft. up from top of rail to a point 16½ ft. above base of rail. This motion was immediately put to a vote, which was so close that it had to be determined by a rising vote. It carried by a vote of 84 to 78.

As to the vertical clearances, the logic of a comment offered by J. G. Sullivan of the Canadian Pacific was seen by all, that the adoption of a clearance measured from top of rail would make any construction illegal if the rail were replaced by one a little higher. The vertical clearance was, therefore, changed to read 22 ft. 6 in. from base of rail.

Aside from this it was voted that the recommendations pertaining to specific structures should be revised to conform to the new diagram and that in the exceptions where the clearance diagram would not apply, which were adopted, new work be substituted for reconstruction work.

Other Committees.—The recommendations of the committee on signals and interlocking and on grading of lumber were adopted with little comment. There was some debate over the revision of the bond clause of the general agreement form, but this and the other revisions proposed were adopted without change. The committee on rail withdrew its recommendations and asked that they be received as information. It was ruled that the findings of the committee on buildings had not been before the association long enough to be passed upon, and they were referred back to the committee for further consideration. While the committee on stresses in track made no recommendations, Prof. A. N. Talbot of the University of Illinois, chairman of the committee, gave some interesting information regarding facts that the tests had already brought out. Most important of these was that the track rail cannot be treated as a girder supported on the ties, but rather the upward pressure of the ties must be considered the load and the axle loads the points of support. The bending moment in the rail directly over a tie has been found to be nearly as great in some cases as between ties.

Evening Session

At the evening session Tuesday, Robert W. Hunt and C. W. Gennet, Jr., gave an illustrated paper on "The Nick and Break Test for Rails." Their main conclusions were that while this method was not infallible, it was more dependable than the A. R. E. A. specifications, and at the same time was more fair to the manufacturer in that it resulted in a much smaller total of rejections. J. G. Sullivan and J. M. R. Fairbairn of the Canadian Pacific, A. S. Baldwin of the Illinois Central and C. A. Morse of the Rock Island, three roads that have bought rail under this test, all spoke favorably of the results obtained. Others thought that while the principle of testing every ingot was good, inspectors in general would not be able to determine the segregation visually.

At the same session Earl Stimson of the Baltimore & Ohio gave an illustrated talk on the equivalent mileage maintenance system on which he has been working for several years. In the discussion that followed it appeared that many doubted the ability of the average section foreman to keep the necessary records properly, but Mr. Stimson thought that the fact that the Baltimore & Ohio was about to extend the system to its whole main line was sufficient proof of its success.

Banquet and Exhibit

The annual banquet was held Wednesday evening. The program was long but interesting.

The National Railway Appliances Association held its usual exhibit during the week at the Coliseum. Among the unusual exhibits might be mentioned that of C. F. Massey & Company, manufacturers of concrete structures, who displayed a full-sized railroad shelter, a cattle pass consisting of a section of 7-ft. reinforced-concrete pipe, and several reinforced-concrete signs; and that of the Miller Train Control Company of Staunton, Va., and Danville, Ill., who gave a visual demonstration of their system by means of a full-size engine cab, an installation therein of the control apparatus and a working semaphore ahead to indicate the condition of the line.

Chicago Engineers Plan to Have Military Lectures

Sixteen engineers, representing various engineering societies in Chicago, have formed a joint committee on military engineering. The purpose is to co-operate with and further the interests of the engineer company of the Illinois National Guard, the proposed military training camp at Fort Benjamin Harrison and such military measures relating to reserve corps of engineers as Congress may pass. To arouse interest on military matters among engineers a course of lectures will be given similar to those delivered in New York. It is planned to have Col. W. V. Jackson open the series about April 20.

Steel Highway Bridge in Johnstown Fails Under Load

Badly Corroded Main Members of Pony Trusses Believed to Have Caused Failure Under Full Load

The steel bridge spanning the Conemaugh River at Maple Avenue, Johnstown, Pa., collapsed March 21 at 5.30 p. m., under the combined weight of six trolley cars and a crowd of about 500 workmen from the local plant of the Atlantic Refining Company. About half the men had boarded the cars, while the remainder were crossing the bridge on foot. Over a score were injured, none seriously.

According to reports the failure was gradual. First there was a loud crack, then another, followed by less violent reports of breaking steel and cracking timbers. The bridge dropped suddenly a foot or more and then fell to the bottom of the river, a distance of 12 to 15 ft. The depth of the water at this point was not over 3 ft. at the time. The cars remained upright and the trusses, though bent out of line, did not fall on the cars or pedestrians. The cars were standing close together, and when the bridge went down were wedged into the shape of a broad V, the position in which the bridge remained after it fell, as seen in the photograph.

This pony Warren-truss skew bridge over the Conemaugh was built twenty years ago by the Edge Moor Bridge Works, according to its own plans and specifications at a cost of $9,500. The span between the two abutments is 150 ft. The steel was badly corroded, and rust had almost eaten through parts of some of the main chords. The top and bottom chords of the east truss broke in two near the Franklin end of the bridge, while on the western side the chords parted in the center of the span.

Preliminary plans for the new $200,000 concrete bridge drawn by A. P. Curry, of Franklin Borough, by a curious coincidence, were mailed to the Water Supply Commission a few hours before the Maple Avenue bridge collapsed. The new structure will be 1000 ft. long, and cross the river at an angle near the location of the wrecked bridge.

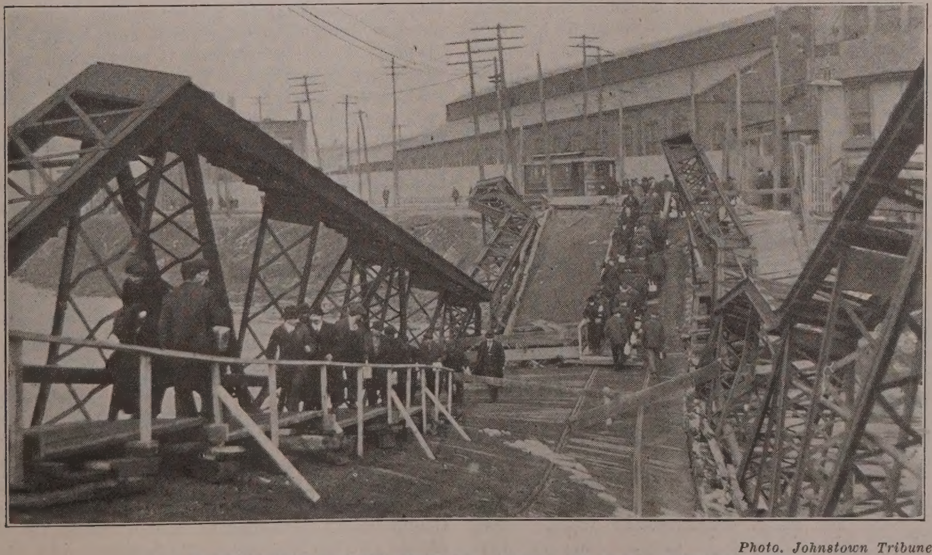


Photo. Johnstown Tribune

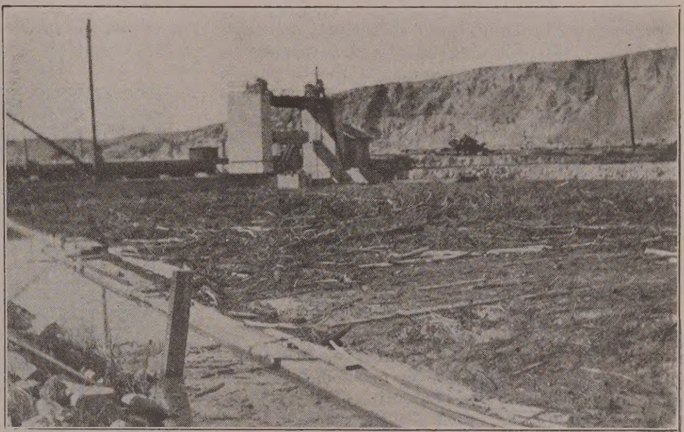
PONY TRUSS BRIDGE FAILURE PROBABLY CAUSED BY BADLY CORRODED STEEL

Engineers' Organization Grows

Information sent out by the American Association of Engineers, 29 South LaSalle Street, Chicago, is to the effect that from March 1 to 25 the association secured positions for fifteen unemployed engineers while thirty openings for technically trained men, ranging in salary from $1,200 to $5,000 a year, were still unfilled at the latter date. The association has now 400 certified members and approximately 150 applications for enrollment are being investigated. No charge whatever is made to employer or employee for the service this association renders.

Large Russian Trade Opportunities Await Development

Tenders on machinery for the construction of an immense irrigation project by the Russian government in Turkestan are desired at once, so that the work may proceed immediately after the close of the war, and everything from cableways to excavators and concrete mixers of the largest size are wanted. In both Moscow and Petrograd the inadequate sewer systems are to be entirely reconstructed at an early date.



THE CURRENT OF THE COLORADO RIVER CAUSED SUCH A TIGHT JAM OF DRIFT DURING RECENT FLOODS AT HANLON HEADING, WHICH IS EAST OF CALEXICO, CAL., THAT WORKMEN WERE ABLE TO WALK OVER THE TOP OF THE ACCUMULATED MATERIAL

Marcus Stow Hill, of Chicago, trade missionary, recently returned after spending seven months in Russia, where he represented eighteen Middle West companies. He reports excellent trade possibilities for all kinds of contractors' equipment.

As an example of the materials on which Mr. Hill was asked to get quotations based on the present price of materials, on the price before the war and on unit costs, the following list is given: One gravity cableway to move 3,200,000 cu. yd. into an earth dam at the rate of 1000 tons per hour; two groups of centrifugal pumps and motors of 50-sec. ft. capacity with lifts of 175 and 350 ft. respectively; two groups of 1000-hp. turbines and dynamos for heads of 200 ft.; 10 miles of 4-in. and 2 miles of 30-in. wood-stave pipe; 3 miles of 28-in. riveted pipe; four dragline excavators; two hydraulic monitors; one ditch excavator capable of handling 300 cu. yd. per hour, or several smaller ones; 7000 ft. of steel sheet piling 35 ft. long; sufficient pneumatic pile drivers to drive the piling in 100 days; pressed-steel forms for a concrete spillway; concrete mixers and rock crushers of large capacity; five 5-ton motor trucks to burn crude oil (not gasoline); rock drills and air compressors.

As soon as work is under way for this project three others of similar size will be undertaken, for which further equipment will be provided by the government. Along other lines, Mr. Hill desires prices on 16,500 malleable-iron fittings, 30,000 couplings and lock nuts, 10,000 radiator valves, cast-iron valves, exhaust fans of small size, and motors; all for immediate delivery.

As to Russian credit, Mr. Hill states that there is an abundance of ready cash in the country, due in great part to the fact that the use of vodka has been abolished. The bank deposits, according to government reports, have increased 1100 per cent. The Russians are prepared to pay good prices because of shipping difficulties, and they will furnish bankers' irrevocable confirmed credits with each order.

Capital and brains are much desired and the Russians are prepared to furnish three-fifths of the capital to carry on many of the businesses and manufacturing plants abandoned by the 150,000 Germans sent to Siberia.

Mr. Hill warned firms against granting exclusive agencies to Russians before investigating the standing of the individual, for many sales agencies are sold from one to another, none of which cares for the actual business since he only intends to sell the agency to the next man. As to mail, he suggests that all correspondence be registered so as to get past the censors quickly.

Mr. Hill will be in Chicago, 1455 Carmen Avenue, for two or three weeks before his return to Petrograd, where he expects to open exhibition rooms adjoining the Russian-American Chamber of Commerce.

Du Pont Offers United States Nitric Acid Plant

In a letter from Pierre S. du Pont, president of the E. I. du Pont de Nemours Powder Company, to U. S. Secretary of War Baker, the powder manufacturer expressed the willingness of his company to spend approximately $20,000,000 for the construction of a nitric acid plant which will make the United States independent of the foreign sources upon which it now relies for a supply of this material which is essential to the manufacture of explosives.

The process which the E. I. du Pont de Nemours Company has purchased requires large units of hydroelectric power at a low cost, and as the necessary power sites are not now available because of Government restrictions, the company has submitted a tentative plan which gives the Government an option on taking over the plant at the end of fifty years provided, of course, that the company will be granted the sites necessary for the construction and operation of the hydroelectric power plants of adequate size.

The prices at which nitric acid would be sold to the Government would be fixed by the Government both in times of peace and war.

Bridge Span Over Tennessee River Near Chattanooga Collapses

Main Truss Members Injured by Shifting Load of Underframes on Passing Freight Car Held to Be Cause of Accident

Span No. 2 of the railroad bridge over the Tennessee River about six miles north of Chattanooga, Tenn., collapsed at about 9.50 p. m., March 17, and went down with eleven freight cars. According to Curtis Dougherty, chief engineer of the Queen & Crescent Route, the accident was caused by the shifting of a load of freight-car underframes carried on a freight car passing over the bridge, striking the trusses and injuring them sufficiently to cause failure. The following data was furnished by Mr. Dougherty at the request of the Engineering Record.

The facts in regard to the collapse of one of the spans over the Tennessee River, so far as they have been developed, are as follows: One of the cars in the south-bound freight train was a flat car loaded with five steel underframes for freight cars. This load became shifted and struck the inside edge of the cover plate of the west end post at the north end of the north span, known as No. 1, causing an indentation in the cover plate at least ½ in. in depth at a height of about 11 ft. above the top of the tie. A similar indentation was found in the southwest end of the post of this span at about the same height, and another mark about 3 ft. higher up, indicating that the load was shifting further out of position during its progress over span 1.

It is supposed that on reaching span 2 this this load of steel underframes had become shifted sufficiently to injure one or more members of the west truss of span 2 by a blow, thus weakening them sufficiently to cause collapse. Proof of this theory was found when one of the steel underframes was recovered from beneath the water and found to be damaged at one end of one of the projecting arms, where some red lead paint which was used for the shop coat of the bridge was found. This blow probably buckled a compression member or severed a tension member, causing the collapse of the span.

This single track bridge of the Cincinnati, New Orleans & Texas Pacific Railway was built in 1877 as a part of the Cincinnati Southern Railway and consists of seven fixed portions and one pivot draw span. Six of the fixed spans are 210 ft. long and No. 2, which collapsed, was 260 ft. long, all of the double-intersection Whipple type.

Forces of the railway company are working on the closing of the span by the use of four plate girders spans, two about 75 ft. long and two about 44 ft. long, supported on the piers on either side of the collapsed span and on three timber towers placed between the piers.

Pennsylvania Engineers Celebrate Twelfth Anniversary

More than two hundred members of the Engineers' Society of Pennsylvania celebrated the twelfth anniversary of the society's founding at a banquet held March 25 at Harrisburg. The banquet was also a farewell dinner to the president, R. Boone Abbott, who was recently appointed superintendent of the Shamokin division of the Philadelphia and Reading, which promotion makes necessary his moving to Tamaqua, Pa. Mr. Abbott, who was the first speaker of the occasion, attempted to resign, but the engineers compelled him to reconsider.

Frederick W. Fleitz, former deputy attorney general of Pennsylvania, spoke on the efficiency of the engineer as being practically synonymous with "preparedness," and discussed the history of engineering from the building of the Citadel of Thebes to the harnessing of Niagara Falls. J. V. W. Reynders was presented with a silver loving cup by his associates and Flavel W. Wright and Thomas Earle spoke in the absence of Agnew T. Dice, who was unable to be present.

Comedy was introduced when the rise of "One, Boone Abbott" was portrayed by the use of moving pictures which offered opportunity for Theodore E. Seelye, Farley Gannett, Henry Evans and Edward Bevan to prove their ability as screen artists.

Propose Building 60 Miles of Hard Roads Around Chicago

Twenty miles of hard roads have already been authorized for Cook County outside of Chicago, and an additional 40 miles is seriously considered. Bids for the first contingent will be called for in the near future. The stretches will complete several through-route roads started last year, notably the roads south of Blue Island and south of Calumet connecting Chicago with the Lincoln Highway at Chicago Heights, Twelfth Street to the West, Archer Avenue southwest of Spring Forest and Milwaukee Avenue to the Northwest. George A. Quinlan, county highway engineer, states that the validity of the $2,000,000 bond issue has not yet been finally passed upon and in any event the construction cannot start before July.

• ANNOUNCEMENT •

The Chicago Milwaukee & St. Paul Railway announces that the All-Steel Transcontinental trains—"The Olympian" and "The Columbian"—between Chicago, Spokane, Seattle and Tacoma are now operated electrically between Three Forks and Deer Lodge, Montana.

The stretch of 115 miles now under electrical operation, is the first unit of the electrified district of this railway, which extends from Harlowton, Montana, to Avery, Idaho, a distance of 440 miles, across the Great Continental Divide.

F. A. MILLER PASSENGER TRAFFIC MANAGER CHICAGO

THE CHICAGO, MILWAUKEE & ST. PAUL ANNOUNCED THE ELECTRIFICATION OF 115 MILES OF ROAD BETWEEN THREE FORKS AND DEER LODGE, MONT., IN AN IMPRESSIVE AND ARTISTIC FOLDER, A PHOTOGRAPH OF THE FRONT COVER OF WHICH IS SHOWN IN THE CUT. THE UNIQUE ANNOUNCEMENT CANNOT HELP BUT EMPHASIZE THE IMPORTANT STEP WHICH THE MILWAUKEE & ST. PAUL HAS TAKEN. THE WORK WHOSE COMPLETION IS THUS HERALDED WAS DONE AT A GREAT COST AND JUSTIFIES WHAT MIGHT BE THOUGHT EXTRAVAGANT PUBLICITY, BUT WHICH REALLY IS ONLY IN PROPORTION TO THE IMPORTANCE OF THE IMPROVEMENT

Work Begun on Los Angeles Elevated Railway

Actual construction work on the elevated railway for Los Angeles is now under way and it is reported that the concrete foundations for the steel columns will be completed before the shipment of steel is received from the American Bridge Company. The Pacific Electric Company was ordered to start work on the elevated structure on or before July 1, 1916, and the approximate cost of construction is $166,000.

Plans are under consideration for a series of umbrella sheds to be constructed over the loading and unloading points.

New York Engineers Vote for Universal Military Training

At Final Session of National Societies' Lecture Course Members Adopt Resolution Calling Upon Congress for Action

New York engineers went on record Monday night in favor of universal military training under exclusive federal control. By a unanimous vote the members of the military lecture course, organized by the four national engineering societies, adopted T. Kennard Thompson's resolution urging Congress to an appreciation of the view that adequate national defense cannot be realized under the volunteer system.

Although ths week's session in the Engineering Societies' Building was the seventh and final meeting of the course, as originally planned, it is proposed to supplement the work already done by week-end encampments, a course of prescribed reading and conferences with army officers. The first conference will be on combat methods, and the instructing officers will be Captain Richard T. Coiner, Corps of Engineers, U. S. Army. An additional meeting of the main lecture course is scheduled for April 24.

After an address by Brig.-Gen. H. F. Hodges, Capt. Thomas M. Robins described the methods of building, maintaining and operating railway lines in the zone of military operations.

News of Engineering Societies

The Albany Society of Civil Engineers heard C. M. Holland deliver an illustrated address on the rapid transit tunnels under the East River, New York City, which proved to be of more than ordinary interest.

The Detroit Engineering Society will hold a meeting Friday evening, April 7, at 46 West Grand River Avenue, at which Prof. D. C. Jackson of the Massachusetts Institute of Technology will speak on high power traction.

The Four State Section of the American Waterworks Association will meet at 1.45 p. m. Saturday, April 8 at Hotel Alamac, Atlantic City, N. J. Mr. Brush of the water department of New York will read a paper on "Freezing of Pipe Lines."

Members of the American Society of Civil Engineers who live in or near Detroit are urged to attend a meeting to be held April 4 in the rooms of the Detroit Engineering Society, at which time the advisability of the organization of a local association will be considered.

The American Chemical Society will meet at the University of Illinois April 18 to 21. The divisional program on water, sewage and sanitation states that there will be a final report by the committee on methods of analysis of water and sewage, and a symposium on activated sludge for which papers have been promised by H. W. Clark, W. R. Copeland, E. J. Fort, Calvin W. Hendrick, Arthur W. Lederer, W. D. Richardson and Robert Spurr Weston.

The New Haven Section of the American Society of Mechanical Engineers will hold a joint meeting with civil, electrical and mining engineers located in the vicinity of New Haven, Conn., April 5. The afternoon session to be held at Mason Laboratory will be devoted to discussions of water power of New England and power requirements of Connecticut industries. Samuel Insull, president of the Commonwealth Edison Company, will discuss progress of economic power generation and distribution that evening at North Sheffield Hall.

The Washington Society of Engineers heard an illustrated lecture on the duties and organization of engineers in war and what engineers in civil life will be called upon to do in defense of the United States, delivered by Major James A. Woodruff, Corps of Engineers, U. S. A., March 31 at the Cosmos Club, Washington, D. C. Lieut.-Col. George P. Howell, Corps of Engineers, U. S. A., will describe the selection, laying out and preparation of camps and cantonments in a territory under military control at the Cosmos Club, April 14.

Personal Notes

THE ROBERT GRACE CONTRACTING COMPANY, of Pittsburgh, has opened an office in Chicago at 208 South LaSalle Street. L. A. Mullins, formerly of Cleveland, is district manager, and W. W. Mathews, formerly assistant engineer with the Sanitary District of Chicago, is engineer. Work has just been started on the Lomax to Griffith 36-mile grade reduction and double-tracking work for the Erie Railroad.

W. M. RODGERS has resigned his position as assistant city engineer for Racine, Wis., to take effect May 1. He leaves the city engineering department after twenty-six years of service.

HOWARD S. REED, civil engineer, of Phoenix, Ariz., should have received credit for substantial help in preparing the article on the measurement of irrigation water by Venturi meters, published in last week's issue of the Engineering Record, page 411. Mr. Reed's knowledge of the peculiar conditions prevailing in the irrigation service of the West was responsible, in large measure, for adapting the Venturi meter to uses on reclamation projects.

B. C. BRENNAN has been re-elected for his fourth term as city engineer for Kenosha, Wis., by a unanimous vote. He will also act as superintendent of the Kenosha water works.

E. O. BRASHEARS, engineer for Yakima County, Wash., has been appointed a member of the advisory committee to consider roads to be constructed by the State of Washington in connection with the development of Rainier National Park.

C. C. WRIGHT has been appointed chief engineer of the Allen & Garcia Company, consulting and construction engineers, Chicago.

J. W. FRAZIER, who formerly conducted his engineering business under the firm name of J. W. Frazier Company, has combined his business interests with R. E. Sheal, formerly with the Wellman-Seaver-Morgan Company, of Cleveland, and the new firm will be known as the Frazier-Sheal Company, Illuminating Building, Cleveland. Messrs. Sheal and Frazier graduated in the same class from Rensselaer Polytechnic Institute, after which Mr. Sheal was with the Pittsburgh & Conneaut Dock Company. For the past fifteen years he has been connected with the Wellman-Seaver-Morgan Company, one of the largest manufacturers of coal and ore handling machinery in the country. The new Frazier-Sheal Company will follow the same general lines of business as the J. W. Frazier Company and is equipped to figure on the design and construction of all kinds of coal and ore handling machinery.

J. E. JOHNSON has left his office at Paducah, Ky., where he practiced as consulting engineer, to enter the employ of the Duluth, South Shore & Atlantic Railway to study railroad valuation work.

BENJAMIN E. JONES, for five years office engineer in the Helena (Mont.) office of the U. S. Geological Survey, has been transferred to the Washington (D. C.) office.

R. B. TINSLEY, who recently resigned his position as local manager for the General Asphalt Company in eastern Venezuela, has accepted a position with the construction department of the Chile Exploration Company as division superintendent of construction, and will be in charge of the construction of the new plant which the company is to build at Chuquicamata, Chile. Mr. Tinsley received his professional education at the Virginia Polytechnic Institute and first engaged in engineering work in 1905 on railroad location and construction and general mine work in the Virginia coal fields. From 1909 to 1914 he was engaged in construction work for the Panama Canal in charge of the field engineering for the Pacific locks and dams at Pedro Miguel and Miraflores, and later as superintendent of construction on the Miraflores locks and spillway dam and the control houses for both Pedro Miguel and Miraflores. When the Pacific locks were completed he was placed in charge of the hydraulic sluicing plant at Gold Hill and the construction of the Cristobal coaling plant of the Atlantic terminals. He resigned from the canal service in 1914 to engage in construction work for the General Asphalt Company in eastern Venezuela, which work was not carried through owing to conditions arising from the European War.

HARRISON W. LATTA AND J. KINTER ROBERTS, formerly connected with the Latta & Terry Construction Company, have formed the firm of Latta & Roberts, Drexel Building, Philadelphia. Some of the more important works carried on by these men were the construction of the sea-wall at the Naval Academy, Annapolis, Md., and a rifle range at the same place together with foundations for a number of the buildings. Messrs. Latta and Roberts also took active part in the construction of jettys for the engineering department of the government at Cape May, N. J., and a number of piers and bulkheads at various points along the Delaware River. They have also constructed powerhouse foundations for large corporations and have had considerable experience in concrete retaining walls and bridges. The firm of Latta & Roberts is organized to carry on the same general line of engineering and construction work.

CLYDE CURTIS of Curtis Brothers expects to complete the irrigation work on the Belle Fourche, S. D., project about May 1, after which he will move his outfit to Clarke, Neb., to begin work on a drainage ditch contract.

LOUIS P. BLUM AND W. A. WELDIN have formed a partnership under the name of Blum, Weldin & Company, with offices in St. Nicholson Building, Pittsburgh, Pa. Mr. Blum was engaged for ten years in the department of public works of Philadelphia, under the direction of C. A. Sundstrom, during which he made property surveys and designed and constructed municipal improvements. For the past fourteen years he has been associated with the W. G. Wilkins Company, engineers and architects, of Pittsburgh. He has been in responsible charge of important railroad, mine and land surveys, and his technical experience includes the design and construction of water and sewer systems and a variety of other municipal improvements. He has prepared preliminary studies of the arrangement of proposed industrial plants and supervised the location and the construction of the structures required for such plants. Mr. Weldin's technical experience includes the design of structures in steel, timber and reinforced-concrete as well as railroad location, underground development of mines, coking practice, and the design of complete industrial, mining and power plants. While construction draftsman with the H. C. Frick Coke Company he had a part in the opening of the several large mines besides making extensive improvements at other mines. He was designer with Geo. S. Baton & Company, engineers, on the plant of the Isabella-Connellsville Coke Company, at Brownsville, Pa. For the past two years Mr. Weldin has been employed as proposal engineer by the Pittsburgh Coal Washer Company, having charge of the preparation of preliminary designs and estimates for coal tipples and washers, mill buildings, pig iron casting machines and coal and coke handling plants.

NEIL W. FRENCH, formerly in the employ of the Indianapolis Union Railway, has become connected with the Illinois State Highway Commission as a junior highway engineer in the bridge department under Clifford Older.

DAVID B. GERTLER has left the employ of L. Moisseiff, consulting engineer, of New York City, to work for the American Bridge Company at Cambridge, Pa.

GEORGE T. ROONEY has been assigned to the compressed air squad which is in charge of the construction of the river tunnel portions of the new subway under the East River at New York City. Mr. Rooney has just recently completed some postgraduate work at the Massachusetts Institute of Technology.

FRANK C. BOGGS, Major, Corps of Engineers, U. S. A., recently general purchasing officer and chief of the Washington office of the Panama Canal, is now in charge of the Montgomery (Ala.) engineer district.

THOMAS G. BUSH, assistant state highway commissioner of the state of Washington since March, 1914, has resigned. He has been active in the business management of the highway department for the last two years and was formerly manager for the Pacific Coast Steel Company of Seattle and of the Spokane branch of F. T. Crowe & Company.

JOHN W. HILL has been retained as consulting engineer for several counties in the northern part of the Great Miami River water shed to make an investigation and submit a report on methods of flood prevention and to review plans prepared by the board of directors of the Miami Conservancy district.

ISAC S. VOORHEES, who has been connected with the Klamath Falls (Ore.) reclamation project for the past six years, has been transfered to the Denver, Col., office of the U. S. Reclamation Service.

JOHN S. GOODMAN, formerly supervisor of the Philadelphia & Reading Railroad at Olney, N. Y., has been appointed engineer of the Harrisburg division succeeding R. Boone Abbott, whose promotion was recently announced in these pages.

Charles R. Ege recently resigned his position as principal assistant engineer of the Washington State Highway Department to become division engineer for the Association of American Portland Cement Manufacturers, with headquarters at Spokane. Mr. Ege has been active in engineering work in the West since 1902.

Edward F. Gorman, of Sunbury, Pa., who for a number of years has been assistant in the office of the resident engineer of the Philadelphia & Reading, has been appointed resident engineer, succeeding Joseph S. Ward. Mr. Gorman spent six years as an architect in Philadelphia, and his promotion comes after eighteen years with the Reading as rodman, levelman, transit man, and finally assistant engineer.

R. Boone Abbott, whose appointment as superintendent of the Shamokin division of the Philadelphia & Reading was mentioned last week, has been promoted to fill the position of superintendent of the Harrisburg division made vacant by the promotion of R. J. Stackhouse.

Clarence C. Jacob has left his position as district engineer for the U. S. Geological Survey at Phoenix, Ariz., to assume his duties as engineer of water resources for the Survey with headquarters at Salt Lake City.

John L. Collins, consulting engineer, 30 Church Street, New York City, has been retained by the borough of Sussex, N. J., to prepare plans and supervise the construction of a sewerage system and sewage disposal works.

Carl W. Schedler, recently connected with the Foundation Company, of New York City, and later with the Hooker Electro Chemical Company, of Niagara Falls, is now superintendent for the Great Western Electro Chemical Company, of Pittsburg, Cal.

E. R. Bowerman, vice-president of the James F. Leary Construction Company, is in charge of the building of a reinforced-concrete bridge over Honeoye Creek at Honeoye Falls, N. Y.

K. E. Lancet has resigned from his position as junior structural engineer with the valuation department of the southern district of the Interstate Commerce Commission, and is now employed by the Cuban Portland Cement Company, of Havana, as engineer on the construction of the new plant at Mariel, Cuba.

F. P. Kemon has left his position as superintendent for the Duquesne Contracting Company, of Pittsburgh, to work for the Robert Grace Contracting Company of the same city. Mr. Kemon will have charge of two bridges that are being built across the Susquehanna River, at Milton, Pa., and, in addition, will superintend the erection of the second half of the 45-arch, 4000-ft. concrete viaduct across the Susquehanna at Harrisburg.

George W. White will have full charge of selecting materials and preparing of plans and specifications for the new roads to be constructed in and near Beaumont, Tex. The amount to be spent for new roads and repairs of old ones is approximately $200,000.

Ernest McCullough, consulting engineer of Chicago, whose specialty is reinforced-concrete design and construction, has become identified with the American Association of Portland Cement Manufacturers, Chicago, as chief engineer of the fireproof construction bureau. He was graduated from the University of California in 1887, and later connected with *Engineering and Contracting* and the *Railway Age Gazette*, and is the author of several technical books.

H. A. Sitterley has been appointed chief engineer of the Low Moor Iron Company of Virginia. Previous to his present appointment, Mr. Sitterley was assistant city engineer of Hornell, N. Y.

Earle L. Waterman, associate professor of sanitary engineering at the Pennsylvania State College, has taken a temporary leave of absence and is working in the office of the sanitary engineer of the state of Michigan.

W. F. Beyr, for many years assistant engineer in government service on lighthouse work and concrete construction in the Panama Canal, has become identified with the editorial bureau of the Association of American Portland Cement Manufacturers, Chicago.

S. C. Baker, after seven years with the United Pipe Company of St. Louis, Mo., has become associated with the East St. Louis & Suburban Railway as engineer and superintendent of construction.

Obituary Notes

Frans Engstrom, city engineer of Altoona, Pa., died suddenly at Pittsburgh, March 20, at the age of sixty-five. He received his education at the Royal Technical Institute, Stockholm, Sweden, and had been in the United States nearly thirty-five years.

Daniel B. Dunn, consulting engineer, of Macon, Ga., recently died at the age of seventy-two years. He was a member of the executive committee of the American Board of Engineers, and one of his latest achievements was the building of the Macon, Dublin & Savannah railroad bridge across the Ocmulgee River about two years ago.

Carl Robert Grimm, author of several works on secondary stresses in bridge trusses, died at Rengsdorf, *bei Neuwied am Rhein*, Feb. 15. Mr. Grimm designed the steel framework which caps the Philadelphia City Hall tower, and was associated with Messrs. Gustav Lindenthal, of New York City, and Frederick C. Kunz, of Philadelphia.

Civil Service Examinations

United States.—The Civil Service Commission announces an open-competitive examination for computer and estimator, salary $1,600 a year, to be held April 12 and 13. The subjects on which candidates will be examined are relative to materials and construction, involving technical and practical knowledge of materials, elementary principles of architecture and details of approved methods of design; specification writing and interpretation; estimating quantities and prices, and training and experience. The requirements are that candidates must be over 20 years of age and must have had a high school education and two years' experience in constructional work of this order.

On April 18 there is to be held an examination for an engineer-economist, salary from $2,000 to $2,500, to be employed in conjunction with the Office of Public Roads and Rural Engineering. This position will relate mainly to road building and maintenance, but on the more theoretical questions of organization, finances, public improvements and systems, and publicity. Candidates will be examined more on their experience than on their education, although a technical school or college training will be required for certain cases. These cases are when candidates have had only four years' experience; in the other case they must have eight years' experience. The age limit is 21 to 50 years.

Two examinations, one for junior signal engineers and the other for junior structural engineers, grades 1 and 2, salaries from $1,200 to $1,680, and from $720 to $1,080 a year, are announced for April 19, to be held at the usual cities throughout the country. Both of these positions are in conjunction with the valuation work of railroads carried on by the Interstate Commerce Commission. Applicants must have a well-grounded technical education in their respective fields, as well as two or three years of practical experience. Theoretical knowledge, especially in the design of signaling or bridge building and other structural work, will be particularly emphasized. The age limit is 21 to 36 years.

The War Department announces that the next examination for the position of second lieutenant of civilian candidates will occur about Aug. 21-25. It is advised that candidates who are not already qualified as eligibles for appointment to the position of junior engineer in the Engineer Department under the Civil Service Commission rules should take this latter examination, which is to be held April 12 and 13.

Forms for any one of the above examinations may be secured from the U. S. Civil Service Commission, Washington, D. C., or at any of the civil service boards in the cities where examinations may be taken. In applying for forms for the examination for computer and estimator or engineer-economist, form 1312, specifying the title of the examination for which it is desired, should be stipulated. In applying for forms for the examination for junior signal engineers and junior structural engineers, form 2039, likewise specifying the title of the examination, should be requested. Information on the examination for appointment as second lieutenant for civilian candidates may be had from the War Department, office of the chief of engineers. It is advisable to secure all information immediately.

Philadelphia.—The Civil Service Commission announces that examinations for the following positions are to be held on the dates given at the City Hall, open only to residents of the city who are at least 21 years of age. It is necessary that applications shall be made and filed four days before the date of examination.

Tracer, City Transit Department, salary $600 a year, to be held April 26. This position requires general knowledge of drawing-room work and requires that candidates shall have had one years' experience.

Transitman, City Transit Department, salary from $1,200 to $1,500 a year, to be held May 3.

Assistant Engineer (abolishment of grade crossings), Surveys Bureau, Department of Public Works, salary $2,500 a year, to be held May 4 and 5. This position involves the supervision of grade-crossing elimination work of railroads in Philadelphia and requires that the candidates have had at least three years' experience in structural work in connection with railroad engineering, as well as two years' additional experience in the design and construction of bridges, abutments, retaining walls, buildings, sewers or other municipal work. Progress report making and preliminary estimating, likewise cost data collecting, are supplementary duties. The examination will be open to only those who are 25 years of age or over.

Structural Draftsman, salary from $1,200 to $1,500 a year, to be held May 4 and 5. This position is in connection with structural steel work, especially piers, bulkheads and other river and harbor improvements in the nature of design, drawing and figuring computation. Applicants should have had at least three years' experience.

Examinations Previously Announced

Date		See Eng. Record
April 3-8	Architectural draftsmen, salaries from $900 to $1,200 and from $1,200 to $1,500 respectively; roadman, salary from $840 to $960 a year, and assistant engineers, salaries $2,100 to $2,500 a year, Philadelphia	March 4
April 17-20	Draftsmen, Highway Bureau, City Transit Department, Bridge Division, Philadelphia	March 11